A. Velikoretsky

TEXT-BOOK OF SURGERY

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TRANSLATED FROM THE RUSSIAN BY
DAVID A. MYSHNE

Проф. А. Н. Великорецкий

УЧЕБНИК ХИРУРГИИ

CONTENTS

Part Two

CLINICAL SURGERY

PREFACE

This textbook of surgery is intended for nurse-training schools. It deals with the role and duties of a scrub nurse. In order successfully to discharge her multifarious and very important duties the nurse must be familiar with the elements of surgery, surgical diseases and their treatment and first aid in accidents.

The textbook discusses in popular form asepsis and antisepsis, principles of organisation and administration of work in an operating room and surgical department of a hospital rather than clinical type, instruments and their care, anesthesia, preparation of patients for operations and postoperative care, administration of first aid in hemorrhages and injuries, and questions of clinical surgery.

All questions are dealt with only in so far as they will concern the scrub nurse in her daily practical work.

The material is presented in a certain succession and although some of the questions may not be of particular practical importance today, they are dealt with in order to facilitate learning.

The author endeavoured to present the material in an intelligible and popular manner.

AUTHOR

PART ONE

GENERAL SURGERY

INTRODUCTION

Surgery is a modified Greek term *cheirourgia*; it is formed of two words: cheir—hand, and ergon—work and therefore means a working by hand.

Surgery is the branch of medicine in which not only drugs, but also various mechanical therapeutic manipulations (incisions, punctures, suturing, reductions of dislocations, etc.) performed by the physician are used. These procedures are designated by the words "surgical operations" or merely by one word "operation".

For a very long time surgical operations were performed on wounds, bruises, ruptured tendons and other injuries only on superficial parts of the body. But severe complications frequently developed even after such operations and not infrequently caused the death of the operated patient. For example, during the Crimean War of 1855-56, 53 per cent of the wounded in the French army died after amputation of an arm, and only 36 of the 1,681 patients with an amputated leg survived, the remaining patients dying of various grave complications, mainly infections of the wounds.

The numerous grave complications and lethal results of the operations at that time were due to the fact that the surgeons were as yet incapable of preventing infections of the wounds.

Only during the second half of the 19th century did the general development of natural science make it possible to solve this difficult problem. The brilliant Russian surgeon N. I. Pirogov was the first to voice the assumption that wounds were infected by invasion of special causative agents which he named "miasmas". In 1863 the famous French scientist Pasteur published the results of his remarkable studies in the essence of the processes of putrefaction and fermentation. Pasteur proved that both these processes were evoked by minute living organisms—bacteria. On the basis of Pasteur's works the British surgeon Lister concluded that the purulence of wounds was also caused by bacteria which found their way into the wounds from the air. To protect the wounds from penetration of bacteria or to destroy these bacteria after their penetration into the wounds Lister began to

irrigate the wounds with a solution of carbolic acid and to treat the instruments and dressing material used during operations with the same solution.

The method elaborated by Lister was given the name of anti-putrefactive or antiseptic. The use of the antiseptic method produced fine results. The number of complications which carried very many of the sick and wounded to their graves sharply diminished.

During the years that followed scientists found that to protect the wounds from infection it was enough to treat all objects which came in contact with the wounds by a physical agent (heat). This new method of disinfection by means of heat was given the name of asepsis.

The antiseptic and aseptic methods of treating wounds revolutionised surgery and almost completely eliminated the danger of infecting wounds. They made it possible to operate not only on the superficial parts of the body, but also on internal organs. Under the protection of asepsis and antisepsis most diverse and complex operations are now successfully performed on such vitally important organs as the lungs and heart.

PREVENTION OF SURGICAL INFECTIONS

GENERAL IDEA OF PURULENT INFECTION

Pasteur's experiments helped to elucidate the causes of infection. While studying the processes of putrefaction and fermentation he found that these processes were due to invasion of the products by minute living organisms, visible only when greatly magnified under the microscope. He noticed that meat broth left in a warm place in an open vessel rapidly grew turbid, flocculated and acquired an unpleasant odour; in a word, these liquids putrefied. On examining a drop of such turbid liquid greatly magnified under the microscope Pasteur discovered innumerable bacteria in it. A similar liquid, boiled and kept in a tightly closed vessel, remained unchanged for an indefinitely long time, and no bacteria were found in it. However, if the vessel was then opened, bacteria soon appeared in it. From these experiments Pasteur concluded that putrefaction and fermentation of a liquid occurred because bacteria gained entrance into it from the air and multiplied in it. The liquid could be prevented from putrefying by boiling and keeping in a closed vessel.

Subsequently Lister came to the conclusion that inflammation and purulence of wounds were due to microbes penetrating into the wounds from the air or from objects coming in contact with them, and proposed certain measures to protect the wounds from penetration of microbes.

Of the various species of microorganisms finding their way into wounds, mainly spherical bacteria (cocci) and rod-shaped microbes (bacilli) develop in them.

Suppuration may be caused by various microbes, but it is most frequently caused by cocci.

The bacteria most frequently found in wounds during purulent processes are *staphylococci* (Fig. 1); these are spherical microbes arranged in clusters resembling clusters of grapes. Staphylococci are generally widespread almost everywhere in nature, i.e., in the air, in the dust of streets and houses, on the skin, in the hair, on mucous membranes, on clothing and in the intestines. They withstand desiccation and are destroyed only by several minutes of boiling.

The second most important pyogenic microbes are the *streptococci* (Fig. 2) which, under the microscope, look like a chain consisting of small spheres. These microbes are encountered in the same places as the staphylococci, but somewhat more rarely; they also withstand desiccation and resist a short period of boiling. Streptococci are the causative agents of such severe and dangerous infections as, for example, erysipelas and sepsis (blood poisoning).

Of the other cocci which may cause purulent infection of wounds mention should be made of the *diplococci*, i.e., the cocci occurring in pairs: the pneumococci, found mainly on the mucous membranes of the respiratory tract, and the *gonococci*—

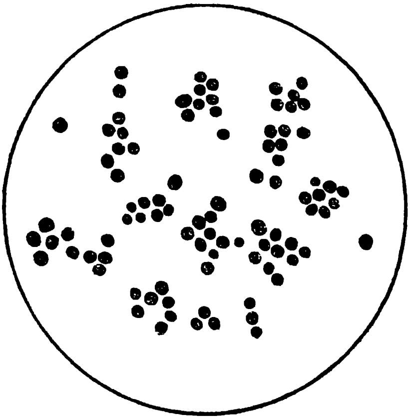


Fig. 1. Staphylococci

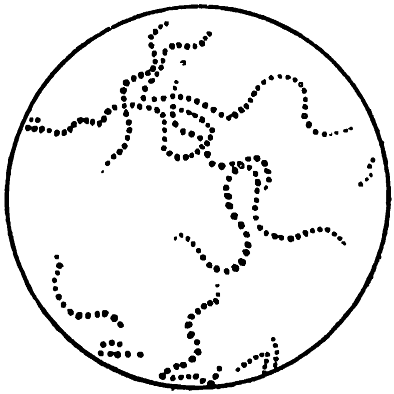


Fig. 2. Streptococci

on the mucosa of the sex and urinary organs. The latter are quickly destroyed by desiccation and heat. Of the rod-shaped microbes purulence is sometimes caused by the tubercle bacillus, typhoid fever and colon bacilli and the bacillus pyocyaneous (infection with this bacillus results in formation of blue-green pus). Lastly, a purulent process may be caused by spore-forming bacteria. These bacteria live for a very long time and endure desiccation; disinfectants hardly affect them (they live for several days in a 1:1000 mercury bichloride solution); some of them can even be boiled for a few minutes (spores of the *Bacillus anthracis*, *Clostridium tetani*, and gas gangrene bacilli). During suppurative processes not one but several different species of bacteria are frequently encountered (mixed infection).

Endogenous and exogenous infection. Microorganisms may infect wounds in different ways. Endogenous and exogenous infections are distinguished. Infection which gains entrance into the wound

from the internal parts of the organism, for example, from other purulent foci in the patient's organism, is called endogenous. This infection spreads mainly through the blood and lymph vessels. Not infrequently latent infection, unobserved for some time, may be found in tissues, especially in cicatrices.

The infection penetrating into the tissues from the external environment is called exogenous.

Most frequently, purulent infection enters through injuries in the skin and mucous membranes (abrasions, wounds, punctures, etc.). Only now and then does infection also penetrate through the uninjured surface of the integuments, for example, into the sebaceous glands or hair sacs (boils), especially by being rubbed into the skin; on the whole, however, intact skin and mucous membranes prevent microbes from gaining entrance into the organism.

Bacteria are introduced into wounds by the injuring agent (for example, knife, needle, etc.) or enter them from the surrounding parts of the skin, the oral cavity, intestines, clothing, dressing material applied to the wounds, water sometimes used for washing the wounds, and instruments (contact infection). Generally bacteria may find their way into wounds from everything that comes in contact with them.

Bacteria may also penetrate into wounds from the air (airborne infection) mainly with dust and droplets of sputum sprayed during conversation and coughing (droplet infection).

Since pyogenic bacteria are widespread in nature, we should be justified in expecting development of severe purulent phenomena after every, even negligible, injury. As it is, though, most of the minor injuries heal without suppuration. This is very largely due to the fact that the organism itself combats and destroys the microbes. Patients who had purulent infection do not develop complete immunity resembling the immunity produced by other infections (typhus, scarlet fever). In some cases the organism of such patients becomes more sensitive to purulent infection and in others, on the contrary, less sensitive.

The variability of bacteria and the different pathogenic power (virulence) of pyogenic microbes also play some role. Pyogenic microbes subjected to long desiccation and, especially, the action of light will produce no purulent disease. Their virulence, their ability to live and reproduce is so weak that they perish before the wound becomes purulent. On the other hand, the bacteria found in a drop of pus taken from a wound of a severe case with symptoms of purulent infection are so virulent that even a negligible number of these bacteria is capable of provoking a severe and sometimes fatal purulent disease. The symbiosis of bacteria is also of some significance; the virulence of microbes may increase, for example, by symbiosis of the Proteus with

cocci or of the colon bacillus with cocci. Lastly, the resistance of bacteria to antibiotics may also differ.

In Lister's time carbolic acid rains were produced in operating rooms to kill the bacteria in the air. This is not done any more because it is considered that the bacteria in the air of a clean and light operating room are not virulent enough to be dangerous for the wounds. On the contrary, all the bacteria on the hands and clothes of the surgeons, as well as on the patient's skin and the different surrounding objects, are considered virulent enough to cause serious infection. The bacteria from purulent wounds are especially dangerous. The more numerous and virulent the bacteria and the weaker the patient's organism, the easier it is for the infection to take place.

Bacteria find particularly favourable conditions for development in tissues damaged by lacerations, burns, poisoning, etc. This is why lacerated wound suppurate much more frequently than do incised wounds with smooth and undamaged edges.

The blood accumulated at the point of injury also offers a lot of nutrient material, thus stimulating multiplication of bacteria and development of the purulent process.

The purulent process in wounds is a result of the interrelations between the organism of the wounded (macroorganism) and the microbes (microorganisms). If the microbes, which have penetrated into the tissues, find requisite conditions for their development, the wound begins to suppurate after a latent (incubation) period of 8-12 hours (sometimes longer).

The general functional state of the organism, its reactive properties conditioned mainly by the nervous system, is one of the factors determining whether or not an infectious disease will develop.

ANTISEPSIS

Antisepsis is a method of controlling purulent infection of wounds and is aimed at destroying the bacteria in the wounds and on everything that comes in contact with them by chemical disinfectants, i.e., agents which kill bacteria.

To combat bacteria, Lister chose carbolic acid because it was known to terminate putrefaction.

With the introduction of this method treatment of wounds produced much better results. Operations were no longer accompanied by inevitable suppuration, and in the overwhelming majority of cases, postoperative wounds began to heal without any signs of purulence.

But Lister's method also had its shortcomings, Carbolic acid irritated and sometimes poisoned the tissues with which it came in contact. The various agents which were proposed to replace

carbolic acid—mercury bichloride, iodoform, potassium permanganate, hydrogen peroxide, and a number of others, also had their shortcomings, since they were very weak or poisoned not only the bacteria, but also the cells and tissues of the human organism.

PRINCIPAL ANTISEPTICS

Chemical substances capable of killing bacteria or at least inhibiting their development are known as antiseptics. As was already mentioned, antiseptics are not always very dependable.

Antiseptics act not only directly on the pyogenic bacteria, but also on the human organism. In some cases they harm the organism and in others they may strengthen its natural defensive powers; for example, they may enhance the capacity of the leukocytes for phagocytosis.

Today there are many different antiseptics, but the following are used most frequently:

Carbolic acid (acidum carbolicum). White, needle-shaped crystals with a sharp characteristic odour. Readily soluble in warm water. Carbolic acid solutions are brownish-red. It is a generally good disinfectant, although it hardly affects spores of bacteria. It does not damage instruments, but should not be used for lacquered things. Frequent washing of hands with it gives rise to eczema. Taken internally carbolic acid is toxic, burning the esophageal mucosa. At the present time carbolic acid is sometimes used in a 5 per cent solution to disinfect instruments.

Mercury bichloride (hydrargyrum bichloratum) is readily soluble in water, but its solutions do not in any way differ externally from ordinary water. It is a colourless, odourless and tasteless liquid. To avoid its possible confusion with other solutions, this poisonous liquid is stained pink or blue. It is ordinarily used in a 0.1 per cent solution, i.e., in a 1:1000 dilution and is a very potent disinfectant. In the presence of protein fluids (blood, pus) the antiseptic action of mercury bichloride ceases. Instruments should not be disinfected with mercury bichloride solutions because they spoil and tarnish. Mercury bichloride is very poisonous. It is used for washing hands (constant use may give rise to eczema) and gloves, and for disinfecting silk.

Lysol (lysolum) is a dark oily liquid with the sharp odour of carbolic acid. It does not spoil instruments and may be used for disinfecting the hands because it has a saponaceous property. As a disinfectant it is stronger than carbolic acid and is moderately toxic. In its pure form it is used to disinfect cutting instruments, in a 0.3-0.5 per cent solution—for irrigation and in a 2 per cent solution—for washing the hands.

Hydrogen peroxide (hydrogenium hyperoxydatum) is a transparent colourless liquid ordinarily used as a 2-3 per cent solution and only freshly made. Liberated oxygen is its active principle. Spraying wounds with hydrogen peroxide helps to arrest hemorrhage and to cleanse the wounds. On contact with the surface of a wound hydrogen peroxide forms a foam; pus, blood clots, necrotic and disengaged pieces of tissue are removed from the wounds together with the foam. It is unfit for disinfecting instruments. It is not toxic and is used for soaking off bandages, and cleansing wounds and cavities.

Potassium permanganate (kalium hypermanganicum). Dark purple crystals, readily soluble in water which they intensely stain red and in stronger solutions—purple brown. Potassium permanganate is not a strong disinfectant but is a good deodorant. It is somewhat toxic. Oxygen liberated during disintegration of potassium permanganate in the wound is its active principle. The shortcoming of potassium permanganate is that it stains linens and leaves spots on the hands. It is used in a 0.1-0.5 per cent solution for washing out fetid wounds, ulcers and cavities; it is also used in a 5 per cent solution in the treatment of burns.

Tincture of iodine (tinctura jodi) is a 5-10 per cent alcohol solution of iodine. It is a strong disinfectant; it irritates and cauterises the tissues, indurates the skin and plugs up pores (tanning action). Long use causes burns and scaling of the skin. Iodine greatly damages metal instruments. It is widely used for disinfecting the skin in the field of operation and the hands.

Ethyl alcohol (spiritus vini) is a colourless volatile liquid with a characteristic odour. In a 50-70 per cent solution it possesses considerable disinfecting and tanning activity. It is used for compresses, disinfecting cutting instruments, washing hands, sterilising silk, etc.

Iodoform (jodoformium) is a crystalline yellow powder with a characteristic strong odour. It acts as a disinfectant only in purulent wounds where, on disintegrating, it liberates iodine.

Silver Nitrate Solution (solutio argenti nitrici). In 1:1000 and 1:500 dilutions it is used for lavage, for example, of the urinary bladder and in more concentrated solutions (1-2 per cent), as well as in solid form (silver nitrate stick)—for cauterising excessive granulations in wounds.

Chloracide is used in a 2 per cent solution. The solution is prepared as follows: 12.0 of potassium hyposulfite (kalii hyposulfurosi) is ground in a mortar and 8.0 of common salt (natrii chlorati) and 5.0 of potassium chlorate (kalii chlorici) are added. The mixture of the salts is poured into a bottle and is moistened with water, after which the bottle is plugged with a rubber plug and put in hot water for 3-5 minutes. The liberated chlorine is

mixed with one litre of distilled water poured into the bottle. The resulting transparent yellow-green solution is used for treating wounds.

Chloramine (chloraminum). The active principle is free chlorine of which chloramine contains 25 per cent. It is a strong antiseptic. Its shortcoming is that it damages living tissue. It is widely used just the same because in a protein medium (for example, in a wound) its bactericidal effect, although diminishing, does not disappear.

Chloramine is used in a 0.5-1 per cent solution for washing out cavities, moistening tampons inserted into wounds and in cases of stable gas poisoning.

Chloramine solutions may be kept in a dark place for no longer than 2-3 days.

Aniline dyes (brilliant green, malachite green and methyl violet) are used in 1 per cent alcohol and water solutions mainly for treating small wounds and for disinfecting the skin before operations.

Rivanol (rivanolum) is used in a 1:2000 solution (golden-yellow liquid) for irrigating wounds and moistening tampons.

Furacilin (furacilinum), a yellow crystalline powder, is used in a 1:5000 water solution. It is antiseptic not only with respect to cocci, but also to the colon bacillus and causative agents of gas gangrene.

Since furacilin solutions do not irritate the tissues, they are used not only for irrigation, application of moist dressings and washing out purulent cavities, but also for administration of 20-25 ml into joint cavities and abscesses, and of 20-100 ml into the pleural cavity.

Sulfonamides. Sulfazole, sulfadimezin, streptocid and other sulfonamide preparations are very widely used.

Unlike the other antiseptics, sulfonamide preparations do not considerably affect the tissue cells, but inhibit the growth of microbes. Owing to this action of the preparations the organism is able to cope with the infection in the wound more easily. For general purulent infection sulfazole is administered in doses of 4.0-6.0 per day. Streptocid is prescribed in doses of 0.5-1.0 several times per day (total daily dose of 4-6g) for severe local and general purulent infection, and for erysipelas. Moreover, it is used in powder form for administration into untreated wounds, which prolongs the period it may be necessary to wait for surgical treatment of the wounds.

Administration of 5.0-10.0 of powdered white streptocid during primary surgical treatment of wounds frequently prevents development of anaerobic and purulent infection in the wounds. Sulfonamide preparations may also be used in the form of emulsions with fish oil.

Subcutaneously streptocid is administered in a dose of 50 ml of a 0.8 per cent solution per 16 kg of the patient's body weight once or twice a day (Streptocidi albi 3.2 Sol. physiologica sterilisata 400.0).

DS. For subcutaneous administration streptocid is sterilised with flowing steam at 85-90°C.

Prescription for intravenous administration: Streptocidi albi solubilis 5.0, Sol. glucosae 1 per cent 100.0. Sterilisetur 20 ml.

Antibiotics. Penicillin is widely used to combat purulent infection. It is obtained by extraction of the active substance from a mold (Penicillium notatum). It is an antibiotic, i.e., a substance formed as a result of the vital activity of other living organisms, for example, bacteria, molds, etc. The basic property of pencillin is its activity against cocci, particularly streptococci and staphylococci, and certain other bacteria even when used in extraordinarily low concentration.

Penicillin differs from all other antiseptics in that it affects the tissues of the organism only in very high concentrations which are practically never used. Thus, penicillin is an uncommonly effective antiseptic; moreover, its activity is not weakened by products of tissue disintegration.

It is much more active, especially against strepto- and staphylococci than are sulfonamides.

It is used as a prophylactic to prevent development of microbes in infected wounds, including surgical wounds, into which infection inevitably gains entrance. In these cases local and general administration of penicillin considerably reduces the possibility of infection developing in the wounds.

Penicillin is very successfully used in various diseases: sepsis, severe purulent processes.

Penicillin administered per os is disintegrated by the gastric juice; it is therefore usually administered intramuscularly.

Penicillin is administered intramuscularly every 3-4 hours for a period of 5-10 days, depending on the nature and severity of the disease. It may also be administered intravenously by the drip method with a physiologic saline solution or glucose at the rate of 30-40 drops of the solution per minute. In this case 50,000-100,000 u of penicillin is added to each 500 ml of the solution immediately before injection of each portion of the solution.

Locally penicillin is used as an ointment containing 200-300 u per 1g (Ung. Penicillini), dusting powder with sulfonamide preparations containing 500-1,000 u of penicillin per 1g of the powdered sulfonamide preparation, in solution (200-250 u of penicillin in 1ml of the solution) for administration in drops, and for moistening dressings and irrigating cavities. For treating purulent processes and infected wounds penicillin is added to a 0.5 per cent novocain solution used for local anesthesia.

A solution of penicillin sodium salt is administered into the subarachnoid space (1,000 u in 1 ml of the solution).

Penicillin is put out as a powder in vials. The number of units of penicillin and the period of its validity are marked on the vials.

Bottled powdered penicillin is usually stored at a temperature of not above 20°C and is dispensed from pharmacies in amounts required for one day.

Dissolved penicillin is unstable and can be kept only for a few hours, preferably in a cold place.

Powdered penicillin is dissolved beforehand in doses of 1 ml of the solvent per 50,000-100,000 u of penicillin, 0.25-0.5 per cent novocain and physiologic saline solutions being used as solvents. Penicillin is dissolved directly in its bottle, the rules of asepsis being very strictly observed. The metal cap is removed from the bottle, the rubber plug is moistened with alcohol and punctured with two sterile needles of the syringe. Through one of the syringe needles 4 ml of the solvent is introduced into the bottle. If the bottle contains 100,000 u of penicillin, each ml of the solution will contain 25,000 u.

Since penicillin is rapidly excreted from the organism, it is necessary to administer the preparation every 3-4 hours, strictly observing the intervals between the injections, to produce the requisite concentration of it in the blood.

To increase the intervals between the injections, administration of penicillin is recommended subcutaneously together with novocain.

Penicillin is also extensively administered locally. In cases of abscesses, mastitis, etc., after aspiration of the pus with a syringe, 50,000-100,000 u of penicillin is injected into the cavity, sometimes repeatedly, which not infrequently completely arrests the process.

In other purulent processes, for example, furuncles and carbuncles, the penicillin solution is administered into the circumference of the inflammatory focus and under it.

Owing to the appearance of penicillin-resisting strains of microbes, preliminary examination of the flora for sensitivity to antibiotics is desirable.

Administration of penicillin not infrequently produces side-effects: headaches, fever and especially dermatitides of different intensity.

Novocillin (novocillinum) is a novocain salt of penicillin in peach oil and constitutes a thick yellowish mass; it is absorbed slowly and is administered only intramuscularly once a day or even once in two days. Adults are usually given 300,000 u.

Before administration the ampules are heated and shaken. As soon as the preparation becomes uniform and viscous it is drawn into a syringe through a thick needle without any solvents.

Ecmonovocillin is a novocain salt of penicillin in a water solution of ecmolin. It is prepared directly before administration from 300,000-600,000 u of the novocain salt of penicillin and 2.5-5 ml of a water solution of ecmolin. It is dispensed in two separate bottles. After cleaning the rubber caps with alcohol, 2.5-5 ml of ecmolin is drawn from its bottle and introduced into the bottle with the novocain salt of penicillin. On mixing, the two preparations form a milky white suspension. The 300,000-600,000 u of the novocain salt of penicillin are all administered in one dose intramuscularly once a day.

Gramicidin is an antibiotic active against all causative agents of purulent and anaerobic infection; it is harmless to all tissues, except the red blood corpuscles, and is administered only into wounds in the form of a fresh 0.04-0.16 per cent water solution.

Streptomycin (streptomycinum) is a crystalline light-yellow powder. It is a very important antibiotic for the treatment of infections caused by certain bacteria against which penicillin is ineffective (tubercle bacillus, colon bacillus, Proteus).

The solutions are prepared like those of penicillin, preferably in a 1 per cent novocain solution, and are administered intramuscularly once or twice a day in doses of 500,000-1,000,000 u, i.e., 0.5-1.0. The daily dose does not exceed 2,000,000 u, i.e., 2.0.

Biomycin hydrochloride (biomycinum hydrochloricum) is a crystalline powder dispensed in the form of tablets. It is active against various species of microbes and is administered for septicemia, peritonitis, purulent processes (phlegmons, abscesses, mastitis), burns and other surgical diseases, especially those caused by penicillin- and streptomycin-resistant microbes. It is administered per os in doses of 0.1-0.2 five or six times a day for five or six days.

Prolonged administration of biomycin and other antibiotics, especially those administered through the intestinal tract, results in affections of the mucous membranes with a fungus (moniliasis) manifested in formation of white membranes and ulcers on the mucosa. Treatment of moniliasis: suspension of antibiotics and administration of nastatine and vitamins.

Terramycin (terramycinum) is similar to biomycin in activity and is administered per os in tablets of 0.1-0.5 three or four times a day.

Tetracycline (tetracyclinum) resembles biomycin and terramycin in activity and is administered per os in tablets of 0.1-0.15, four or six times a day.

Levomycetin (levomycetinum) is a crystalline powder. It is administered per os in tablets of 0.25-0.75 six times a day for infectious processes in the abdominal cavity, especially those involving the colon bacillus. Administration of levomycetin

before operations on the gastrointestinal tract reduces the danger of infection from the intestines.

Synthomycin (synthomycinum). Levomycetin is its active principle. It is administered, like levomycetin, per os in tablets of 1.0 four or six times a day. It is also used in the form of 1-5 per cent and 10 per cent emulsions for the treatment of purulent wounds.

ASEPSIS

Asepsis is a method of preventing wounds from becoming infected with pyogenic bacteria. By this method all objects which come in contact with the wounds (instruments, dressing material, suturing material and linens) are disinfected by physical means (heat).

Today all of the surgical work, the layout of operating and dressing rooms and everything done in surgical departments must be based on strict observance of the rules of asepsis.

STERILISATION BY PHYSICAL METHODS

To destroy pyogenic bacteria by physical means the following methods are used: dry heat, open flame, boiling and steaming under pressure.

Dry heat. Although this method is quite reliable, dry-heated instruments spoil and even become unfit for further use.

Open-flame sterilisation is not particularly dependable; besides, it spoils instruments. Mainly basins and instruments are treated by this method which consists in pouring alcohol over them and igniting the alcohol. This method should be abandoned, and we mention it only because it is still being used.

Boiling is the most widespread and reliable method of sterilisation. Instruments may be boiled in any vessel, but *sterilisers* (Fig. 3) are ordinarily used. A steriliser is an elongated metal box with a cover. Water is poured into it and heated to the point of boiling. When the water begins to boil, the instruments lying in a tray which has numerous perforations in its bottom are placed in the steriliser. After boiling, the tray is removed from the steriliser with the aid of special hooks (Fig. 4), the water draining through the perforations into the steriliser. As soon as the water has run out, the tray with the instruments is placed on the instrument table covered with a sterile cloth.

By boiling it is possible to sterilise, in addition to instruments, drains, rubber gloves, glass and enamel articles (basins, bottles, etc.). Instruments must be boiled in water for at least half an hour, but by using a 1 per cent sodium bicarbonate solution or

a 2 per cent solution of borax, it is enough to boil them for fifteen minutes. In soda solutions metal instruments do not tarnish and the nickel-plating does not spoil during boiling. The dressing material is boiled only in cases of extreme necessity. The tray with the instruments is placed in the steriliser only after the water begins to boil.

Glass articles are boiled separately. They cannot be placed in boiling water because they may crack. They are therefore placed

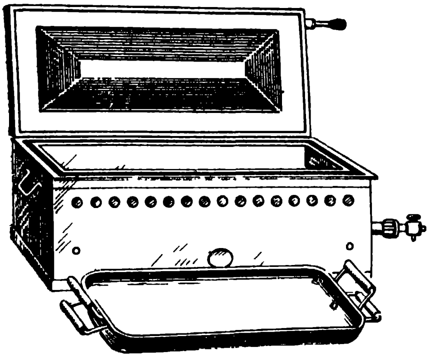


Fig. 3. Steriliser

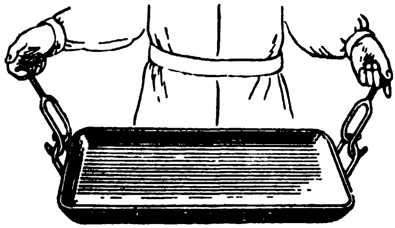


Fig. 4. Removing the tray by means of hooks

in the steriliser filled with cold water which is heated to the point of boiling.

Syringes are also boiled in a separate steriliser. Before placing them in water (which must be cold) they have to be taken apart and wrapped in gauze.

Autoclave. The most reliable method of sterilisation is steaming under pressure in an apparatus called an autoclave. Almost anything can be sterilised in an autoclave: linens, dressing material, clothing, etc. Only leather articles, rubber and instruments with an optic system are spoiled by such sterilisation.

An autoclave is a boiler with double walls (Fig. 5). The space between the walls is filled with water, the autoclave is covered with a lid which is tightly fastened with screws (*S*), and the burner located under the bottom of the autoclave is lighted. The steam forming in the autoclave after the water begins to boil cannot escape because the lid is airtight, for which reason the pressure inside the autoclave rises. The higher the pressure, the higher the temperature of the steam. If the pressure inside the autoclave rises one atmosphere above normal, the temperature of the steam will be 120°C; if the pressure rises two atmospheres, the temperature will be 134°C, etc.

To prevent it from bursting under excessive pressure the autoclave is provided with a safety valve (*SV*). The safety valve is a small opening in the lid of the autoclave covered with a disk which may be raised and lowered on hinges. The disk is connected with a lever from the other end of which a small weight is suspended. When necessary this weight can be increased or reduced. When the pressure in the autoclave reaches a certain level (one, two or three atmospheres) the weight is lifted and the excess steam is allowed to escape.

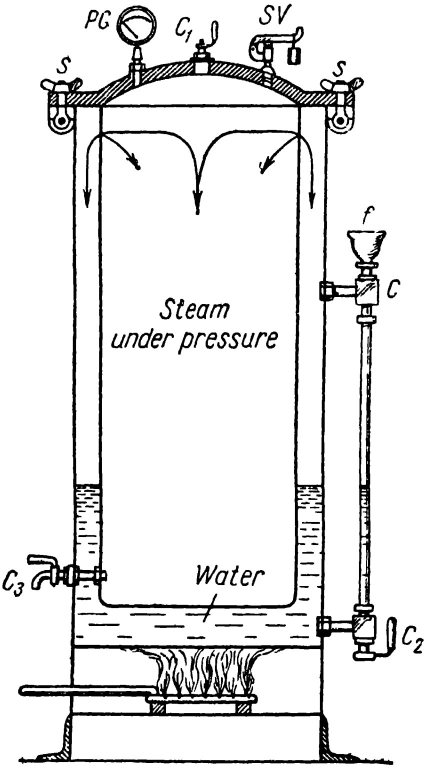


Fig. 5. Autoclave

In addition to the safety valve, there is another device on the lid—a pressure gauge (*PG*, Fig. 6). The interior of the pressure gauge communicates with that of the autoclave through a small opening in its lid. The pressure in the pressure gauge is communicated to the pointer fastened on its wall. Moving over the dial, the pointer shows, at each given moment, the pressure in the autoclave.

Owing to this construction, the person who is doing the sterilising can easily tell when the pressure of steam in the autoclave reaches the level corresponding to the temperature required for sterilising the articles placed in the autoclave.

The autoclave also has the following devices: a glass water gauge, showing the level of water in the autoclave, a water drain cock (C_2) and a steam release cock (C_3).

Reliable sterilisation does not necessarily require a pressure of three or four atmospheres, one or two atmospheres being quite enough. The temperatures of the steam (120 and 134°C) corresponding to these pressures kill pyogenic bacteria within a few minutes. For safety's sake such temperatures are maintained for 30-40 minutes.

Sterilisation is usually performed as follows: first, the autoclave must be filled with water. Then the articles to be sterilised must be placed in the interior chamber of the apparatus, the

chamber must be closed, the lid screwed on and the apparatus heated with cock C_3 open. As soon as steam begins to escape in a uniform jet, which indicates that most of the air has been driven out, the cock must be shut and the pressure gauge watched. When the pressure rises to one atmosphere, cock C_3 must be opened once again and some steam released to let out the remaining air. Following this the cock must be shut and the pointer of the pressure gauge allowed to reach point 1. This moment is considered the beginning of sterilisation. All through the period of sterilisation the pointer must be between points 1 and 2; with a rise in pressure the burner must be turned down or some steam released through cock C_1. After the end of sterilisation all the steam must be released and, when the apparatus has somewhat cooled, the lid must be taken off, and the sterilised things removed. There is no need waiting until the apparatus has completely cooled, or all the sterilised material will be wet.

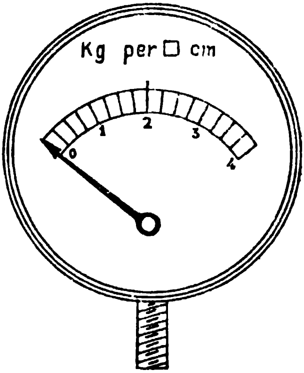


Fig. 6. Pressure gauge

Sterilisation of solutions. The sterile solutions now widely used in surgical work are: a 0.85 per cent common salt (physiologic saline), a 5 per cent common salt (hypertonic), and 0.25 and 0.5 per cent novocain solutions.

The physiologic saline solution is used for subcutaneous and intravenous injections, lavage of viscera (for example, intestines) during operations, rectal drip, etc.

The solutions are sterilised in an autoclave or by boiling, preferably intermittent, i.e., for 30 minutes and after an intermission for another 30 minutes. To prepare novocain solutions, the physiologic saline solution is sterilised and powdered novocain is added to it. After the novocain has dissolved the solution is heated to the point of boiling (appearance of large bubbles). Liquids are sterilised in an autoclave in glass containers plugged with cotton and not with corks, because tightly plugged glass containers may burst.

Liquids are usually sterilised in the glass vessels in which they are dispensed; the corks with which the vessels are plugged after sterilisation are also sterilised.

Drums. The dressing materials and linens are placed in special tightly closed drums (Fig. 7) and are taken to the dressing or operating rooms after the end of sterilisation. Before placing the drum in the autoclave, the holes in its sides or lid and bottom should be opened to admit steam. After sterilisation, as the drum is removed from the autoclave, these holes must be closed.

The drum must not be packed too tight or not enough steam will pass through the articles and the latter will not be adequately sterilised. Canvas bags or even pillow-cases may be used for sterilisation if no metal drums are available. The rules of sterilisation must be strictly observed.

Before packing, the drums must be wiped dry. The lid must be closed and fastened and the grid opened. All non-sterile drums should, as a rule, be kept apart from the drums containing sterile material.

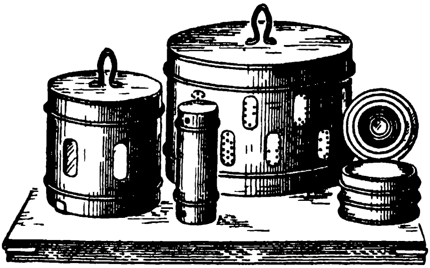


Fig 7 Drums

In some surgical institutions a piece of oilcloth or a wooden tag is fastened to the handles of each sterilised drum with an inscription indicating the date of sterilisation, the amount of material in the drum and the name of the person who did the sterilising.

Of the various methods of ascertaining the sterility of the material the method of bacteriological control is the most precise.

Since this method cannot always be used, chemical and physical methods are employed to check on the autoclave performance. The chemical method is based on the change in the colour of iodised starch test paper due to the action of heat, and the physical—on melting of sulphur.

DISINFECTING THE HANDS

In addition to observing the general rules of hygiene, the medical personnel must pay particular attention to the state of their hands.

Care of the hands. It should be remembered that only hands which are very well cared for can be satisfactorily disinfected. Hands contaminated with pus or having a hardened skin covered with cracks, abrasions, hangnails, scratches or pustules cannot be satisfactorily disinfected. It should be noted that constant disinfection and frequent washing make the skin coarse, produce cracks in it and expose it to injury. Care of the hands with a coarse skin consists in hot baths and embrocation of equal amounts of vaseline and lanolin for the night (Vaselini, Lanolini $\bar{aa}$ 20.0). Glycerin, pure or in a mixture (Ammonii caustici, Glycerini, Aq. amygdalarum $\bar{aa}$ 20.0) may also be used.

Care of the fingernails. Care of the hands includes care of the fingernails, which means that the latter have to be appropriately trimmed. All conventional ideas of beauty and fashion must be

relinquished. To begin with, there must be no manicuring, i.e., the fold of skin overlying the margins of the nails must not be cut off.

Fig. 8 shows an improperly trimmed nail under whose free border dirt is likely to accumulate. Even when the nail is kept clean it is difficult to disinfect the furrow under it properly. The nail must be cut off with a scissors and filed as shown in Fig. 9.

Methods of disinfecting the hands. The hands are disinfected by many different methods, but most frequently by scrubbing with soap and boiled brushes (at least two brushes are used). The hands may be washed either with warm water running from a tap or in clean basins. The basins should first be boiled or well disinfected with carbolic acid or mercury bichloride. When changing the water (2-3 times), the assistants must not allow their fingers to get into the basins which must be held as shown in Fig. 11 and not as in Fig. 10.

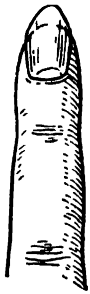


Fig 8. Improperly trimmed nail

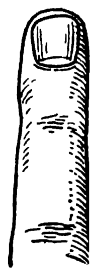


Fig. 9 Properly trimmed nail

As a rule, warm water is used, because in such water the superficial layers of the soiled skin soak off and come off more readily, and bacteria are discharged from the deeper layers. The hands and forearms, up to the elbows, are scrubbed with a brush for about 10-15 minutes; the fingernails, nail beds (Fig. 12) and folds of skin on the hands are cleaned very thoroughly. Hand-scrubbing requires a certain skill, or else some parts of the hands may be neglected. Formerly, after washing, the hands were disinfected with mercury bichloride or carbolic acid; now tanning of the skin on the hands is more current. For this purpose the hands are rubbed down for five minutes either with alcohol (with the aid of sterile gauze) or an alcohol solution of iodine; they may also be dubbed with an alcoholic tannin solution (5 per cent) or an iodine tincture (the finger tips and nail beds). Under the action of these substances the skin shrinks, the openings of the skin glands close up, and the bacteria in the deeper layers of the skin and about the nails cannot penetrate to the instruments, dressing material or wounds. According to bacteriological tests, treating the skin of the hands with tanning substances produces better results than do all the other

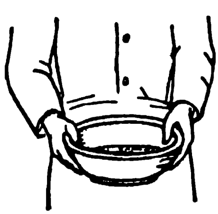


Fig. 10. Wrong way to hold basin

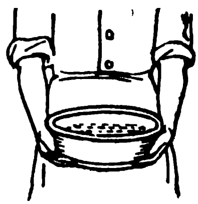


Fig 11. Right way to hold basin

methods. In some hospitals the hands are tanned somewhat differently, i.e., without preliminary washing in hot water. In hot water the skin swells and the openings of the skin glands close up, owing to which the disinfectants and tanning substances act only superficially without penetrating into its deeper layers. The hands are therefore tanned for at least five minutes with one of the aforementioned solutions, most frequently with a 5 per cent alcoholic tannin solution either after washing for a short time in cold water often without brushes or even without any washing. Prolonged use of tanning substances spoils the skin which is liable to grow coarse and creased. With this method of disinfection it therefore requires particularly thorough care.

Hand-scrubbing with 0.5 per cent hot ammonia water is now very widely practised. The hands are scrubbed for five minutes in a basin, in two changes of the water (two and a half minutes in each). Sterile gauze mops rather than brushes are used. After such scrubbing, the hands are dried with a sterile towel and are wiped with alcohol for five minutes. In addition to being cheap, fast and simple, this method does not injure the skin, i.e., the latter does not grow coarse and does not crack or peel.

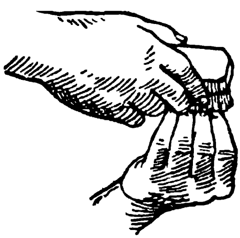


Fig. 12 Scrubbing the hands with a brush

While scrubbing the hands, and especially after scrubbing them, care should be taken to avoid touching anything that is not sterile.

The most thorough scrubbing of the hands and their subsequent disinfection still fail to guarantee complete destruction of bacteria. Bacteriological tests show that an especially large number of bacteria appears on the hands 20-30 minutes after scrubbing, particularly if the hands are moist (for example, moistened by blood during an operation).

Gloves. To attain absolute sterility of the hands during an operation, sterile rubber gloves are worn. This method has great advantages, but does not obviate the necessity of scrubbing the hands because a glove may accidentally tear and a drop of sweat (the hands in rubber gloves perspire profusely) containing a mass of bacteria (so-called glove juice) may come out of the glove. Heavy gloves interfere with the sense of touch, while thin gloves often tear—they usually last only for one operation (which is very expensive). At any rate, wearing gloves after preliminary hand-scrubbing ensures the greatest possible sterility. The gloves worn during operations require thorough care. Immediately after use they must be washed and thoroughly dried. They must not be used for clean operations after operations on septic cases. Before putting them on they must be examined to make sure they have

no holes. For this purpose they are inflated to see if they do not let through any air. It is best to immerse the inflated gloves in a basin of water. When this is done, even the minutest puncture is revealed by the escape of air bubbles. Slightly torn gloves can be easily mended with pieces taken from discarded gloves. The torn places and the patches are carefully washed in benzine and coated with a special rubber glue; after a little drying the patches are firmly pressed down until the glue is completely dry. A special set of gloves is used for operations and dressing wounds in septic cases.

Rubber gloves are sterilised either by boiling in a soda solution or in an autoclave. For sterilisation in an autoclave they are dusted with talc and wrapped in gauze.

Since gloves rapidly spoil from boiling and autoclaving, their sterilisation with mercury bichloride has been proposed. After thorough washing the gloves are placed for an hour and a half in a mercury bichloride solution (1:1000), following which they are turned inside out and placed in a mercury bichloride solution for the same length of time again. Then the gloves are washed in sterile water, dried and dusted with sterile talc, after which they are kept in a sterile sheet.

Gloves sterilised by boiling are put on hands moistened with alcohol or sterile vaseline oil. Dry gloves sterilised in an autoclave are best worn on dry hands, after an inside dusting with sterile talc.

They are donned before the operation, a sterile gown being put on first. After the gloves have been put on they are washed in a mercury bichloride solution (1:500) or in a 2 per cent chlor amine solution, following which they are wiped with alcohol.

Preparation of Suturing Material. *Silk.* Surgeons use braided and twisted white and black silk. The disadvantage of the latter is that it is liable to curl up and become tousled; knots which interfere with suturing appear on long threads. Braided silk is the strongest and most convenient, but expensive. Surgical silk usually comes in small skeins; its threads are of several thicknesses designated by numbers beginning with No. 00 which is the thinnest. Nos 2, 3, 4, and 5 are most generally used.

Without special treatment silk is difficult to sterilise even in an autoclave. Moreover, aseptic silk thus produced has a considerable shortcoming—it becomes easily infected. The microbes penetrating deep into the thread find nutrition in the tissue fluid with which it is saturated and at the same time remain out of reach of the white blood cells (phagocytes). Suppuration therefore often appears about buried sutures. The best results are produced by the use of *antiseptic silk.*

There are many ways of preparing antiseptic silk, but a modification of *Kocher's method* is most frequently used. By this method silk is degreased for 12 hours in ether and 12 hours in alcohol

and is then boiled in a 1:1000 mercury bichloride solution, after which it is wound on glass spools. The person who winds the silk on spools must prepare his hands as though for an operation and must put on sterile rubber gloves. The spools with the silk wound on them are placed in a fresh mercury bichloride solution for another 24 hours, after which they are transferred for storage to special glass jars with ground-in stoppers. The jars are filled with alcohol. The spools must be completely immersed in alcohol with a layer of at least 4-5 cm of alcohol over them.

Prolonged boiling spoils silk; the threads become weak. On the other hand, less thorough boiling will not sufficiently sterilise the silk. There are several methods of sterilising silk, including the simple procedure of treating it with malachite green. The silk is wound on spools (no more than three rows) and immersed for five minutes in a 1 per cent boiling water solution of malachite green, after which it is transferred to a sterile jar with 180-190 proof alcohol to extract the excess dye. In this jar the silk is kept until used.

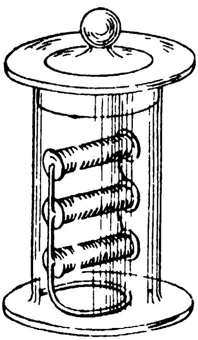


Fig. 13. Jar with silk

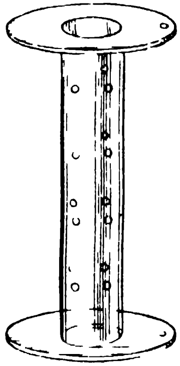


Fig 14 Glass spool

The thinnest silk (No. 00) is used for vascular sutures. Thin silk (No. 2 and No. 3) is employed for ligatures and intestinal sutures; heavier and stronger silk (No. 4) is used for suturing aponeuroses and the skin.

The length of the thread may vary with the type of suture—continuous or interrupted—and the depth of the wound. For an interrupted suture a thread about 25 cm long is usually used.

Other threads. Silk may be replaced with linen or cotton thread and with synthetic materials (kapron, etc.).

Metal wire (silver or aluminium bronze) may also be employed for suturing; it is sterilised best by boiling in physiologic saline solution. But wire has its shortcomings, for which reason metal sutures are made only in bony tissue. Bone fragments can also be joined by metal *plates* which are fastened with screws or metal pins. They are sterilised like instruments. Lastly, the skin can be joined by Michel clips which pierce the edges of the incision with sharp hooks and, when compressed, hold them in contact. The clips are sterilised by boiling.

Catgut. The shortcoming of the aforementioned materials when used for suturing is that they remain in the tissues for many years after the wound has healed. It is therefore desirable to re-

place them with a material which is resorbed after the tissues have grown together. Such material is catgut. It requires particularly complex processing. Catgut is made in factories and is put up in tubes or sealed packages. In hospitals catgut is usually prepared as follows: it is coiled in small skeins and seasoned for eight days in a solution containing one part iodine and one part potassium iodine in 100 parts of water (so-called Lugol's solution). After eight days the solution is changed and the catgut is kept in the new solution until used.

Catgut may also be disinfected with iodine vapours; this is so-called dry iodised catgut which is prepared as follows: strands of catgut degreased in ether for 24 hours are dipped in a 1 per cent potassium iodine solution and are suspended from a glass stand or from threads in a jar with a ground-in stopper. Iodine crystals are placed on the bottom of the jar (5 g for a 2-litre jar).

To reduce evaporation of iodine, the jar is sealed with paraffin. Within 5-7 days (depending on the thickness of the strands) the catgut turns black and is considered ready for use.

DRESSING MATERIALS

White *gauze* is a degreased, loosely woven, very soft and highly absorbent cotton fabric. It is an indispensable dressing material and is cut into pieces of various sizes and shapes: small square flaps (10 ×10 cm), larger pieces—compresses (50 ×20 cm or 90 ×20 cm) and long strips tampons (30 ×5 cm or 30 ×10 cm); it is also rolled into balls. Moreover, gauze is used for bandages to keep the dressing material on the wound (this will be discussed in detail in the part of the book entitled *Desmurgy*).

Cotton. Unprocessed cotton is not absorbent and is used only to protect wounds from impacts and pressure. Absorbent cotton (degreased by long boiling in an alkali) is capable of absorbing liquid and is used for dressing; it is not applied directly to wounds but is placed above the gauze.

Small swabs are used for painting the skin with tincture of iodine. These are prepared beforehand by winding cotton on ends of thin sticks 10 and 15 cm long. To keep the cotton in place, a small piece of it is spread out and pressed against the stick before it is wound on it.

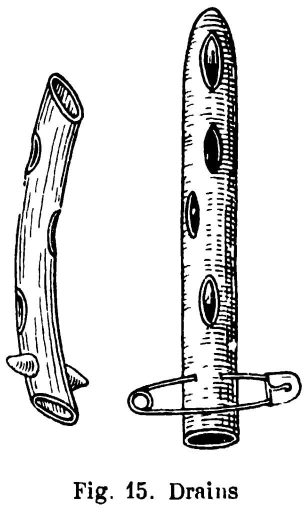


Fig. 15. Drains

Lignin is a woody tissue. Like

cotton it is not applied directly to wounds but is placed on top of gauze. It is an excellent absorbent, but does not tolerate boiling.

Drains. A drain is a glass or rubber tube with several holes. It is used for draining pus and other fluids (blood, lymph, etc.), for which purpose it is inserted in the lower part of the wound. The end of the drain inserted into the wound is bevelled. To make sure that the drain does not slip out of or fall into the wound when inserted in a cavity, for example the thoracic or abdominal cavities, it should be fastened to the dressing. For this purpose the outer end of the rubber drain is pierced with a pin (Fig. 15). When using a rubber drain, it is necessary to count its holes to be sure of removing the entire drain. After removal the drain is washed, preferably in ammonia water, and is sterilised by boiling.

Not infrequently a rubber drain tube split in half or only a longitudinal strip cut out of it is used to drain blood after an operation or pus from abscesses. Strips of rubber from rubber gloves may also be used for these purposes.

SURGICAL SERVICE TO THE POPULATION

In the Soviet Union surgical work is done mainly in specially equipped medical institutions—surgical hospitals, surgical departments of general hospitals, surgical departments of dispensaries and polyclinics. But sometimes, for example, in cases of injuries, fractures, hemorrhages, etc., it is necessary to administer *first aid* at the place of the accident or nearby. First aid is extremely important, but it cannot always be administered by a physician, for which reason the entire intermediate medical personnel must be taught the basic rules of administering first aid. It is also desirable to make as many laymen as possible familiar with the elementary rules of administering first aid.

In addition to first aid administered at the place of accident it is sometimes also necessary to administer *emergency aid*. Emergency aid is administered to patients brought to medical institutions at a time when the medical personnel have already finished their regular work and have gone home, and when only the physicians, nurses and orderlies on duty are in. Administration of urgent aid is also very important, and all surgical institutions must therefore always have in readiness everything required for administering it. It is very important that the population should be able quickly to deliver to a medical institution any patient in need of such aid. This requires a special organisation with transport facilities at its disposal.

Many surgical patients do not need hospital treatment. In cases of minor injuries and mild inflammatory processes, as well as after discharge from hospitals, the necessary treatment may be given in dispensaries or polyclinics where the patients report for particular procedures and then go home. Patients coming for consultation to dispensaries and polyclinics for the first time are also given their initial medical examination. This form of aid is known as *out-patient* or *polyclinical aid.*

The most complicated and thoroughgoing surgical operations can be performed only in specially equipped and properly adapted

medical institutions in which patients are placed for a rather long time. Administration of surgical aid under these conditions is referred to as *hospital surgical aid.*

Preparation of the patient for an operation, assistance to the surgeon during the operation and organisation of postoperative care of the patient require concerted work of the surgeon and all the other personnel of the medical institution. All the physicians, nurses and orderlies of a surgical department must be well trained, have enough experience and observe strict surgical discipline.

OPERATING ROOM

Operating rooms must be designed so that the danger of infecting surgical wounds during operations may be reduced to the minimum.

For this purpose the following rules must be observed:

1. Operating rooms must be as far away as possible from all sources of infection (away from toilets and bathrooms, entrances and exits, etc.).

2. They must have facilities for quick, easy and complete ventilation, as well as for cleaning the walls, ceiling and floor.

3. They must be well ventilated and heated.

4. They must be provided with good natural and artificial lighting.

It is very desirable that surgical departments should have at least two operating rooms—one for clean (aseptic) operations and the other for septic cases. If, for some reason or other, both types of operations have to be performed in the same operating room, special caution should be exercised to prevent infectious material from spreading through the operating room and from remaining on the equipment and instruments, otherwise infection may be carried into clean wounds during subsequent operations. Dressing material and linens soiled with pus must therefore never be left lying about; they must be placed in basins or buckets which are easily disinfected with carbolic acid or lysol solution.

Care must be taken to prevent pus from running on to the operating tables, pillows and the floor. For operations during which a discharge of large amounts of pus is unavoidable (for example, in purulent pleurisy) it is necessary to cover the table with an oilcloth, prepare a basin for the pus, provide a gutter, etc. If the operating table, bolsters or oilcloth are soiled with pus, they must be thoroughly scrubbed with lysol or carbolic acid immediately after the operation. But, if pus happens to run down to the floor, it must be collected before it is carried all over the operating room, and the floor must be disinfected. The instruments used for work on infected tissues must immediately be

placed in a carbolic acid solution and then scrubbed in it, the hands wearing rubber gloves. Instruments must not be scrubbed with brushes in a sink, so as not to spread the infection. They must be boiled for fifteen minutes before being stored and may be used for another operation only after a repeated sterilisation.

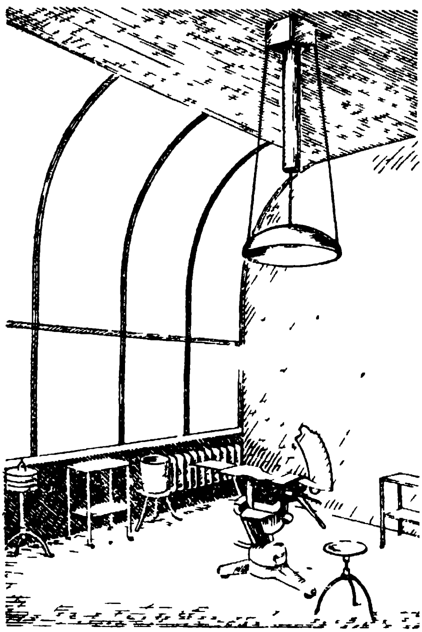


Fig 16 General view of operating room

To avoid bringing dirt into the operating room on their shoes, the personnel must put on special canvas stockings before entering it.

Lighting. Artificial *lighting of the operating room* plays a very important role. Bright lighting of the whole room is not necessary. The light must be concentrated on the operative field, must be diffused and must produce no shadows. The most convenient lighting for operating rooms is providep by modern shadowless lamps from which the refracted and reflected rays of light fall, crossing each other, on the operative field, which prevents the hands of the surgeon and his assistant from throwing shadows on the operative field. This is very important in cavitary operations, especially in very deep ones. If no such lamps are available, special reflectors are used. If there is no electric lighting, spirit or kerosene lamps serve the purpose, although they make work considerably more difficult. It should be noted that *any* operating room, even with most perfect electric lighting, must always have in reserve electric lamps with a battery and, if the worst comes to the worst, kerosene lamps, *in good order*, and matches. Failure to observe this rule may get the surgeon into difficulties.

Heating. The temperature in the operating room must be even, not below 20-22°C for cavitary operations and 18-20°C for all other operations. To control the temperature, the operating room must have a thermometer. An overheated operating room makes for profuse sweating of the personnel's hands, which does not favour asepsis.

Ventilation. Large medical establishments now have special devices which ensure not only fresh air but also a certain (desir-

able) temperature and humidity (air conditioning). It is not always possible to provide operating rooms with air conditioning facilities, but it is always necessary to have good ventilation in them. Windows of an operating room should not be opened because of the danger of admitting pyogenic bacteria together with the dust from the street.

The walls, ceiling and floor must wash easily. The walls and ceiling must be absolutely smooth and must have no cornices or other projections and recesses. The corners in the operating room must be rounded. It is best to tile the walls or coat them with oil paint. The walls should preferably be painted light colours. Greenish, bluish, grey or blue are considered the most appropriate colours (if not for the whole operating room, then at least for the dado). The floor of the operating room must be

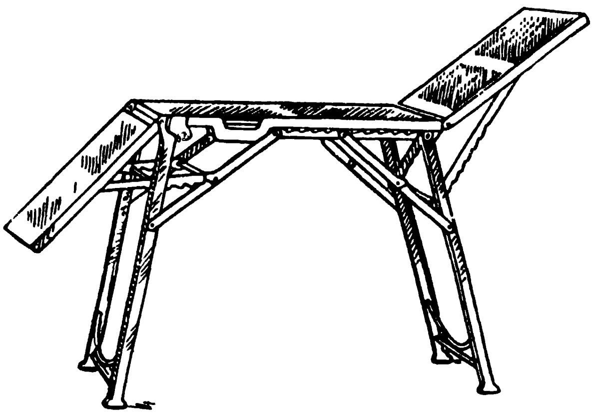


Fig. 17. Operating table

smooth and impermeable to water, and must have a water drain. Linoleum covering is undesirable, but in any case the floor should be easy to wash. It should be made with a slant either toward the operating table or to one of the walls with the drain in the lowest place. The floor must be kept absolutely clean.

The *operating room furniture* must consist only of things necessary for routine work. The special equipment (motors, auxiliaries for the table, etc.) should be kept in the same room as the instruments and brought into the operating room, if needed, only before operations.

The sinks for hand-scrubbing should be installed in the scrub-up room.

Operating tables. The *operating table* is one of the most important parts of the equipment. There are many different models of operating tables, owing to the necessity of imparting the most

diverse positions to the patients during operations. The more changes in the patient's position the table allows, the more convenient it is. Such a table enables the surgeon to perform operations in positions which are the most convenient for both surgeon and patient.

Wooden white-enamel painted tables are the simplest, but are convenient for operating on patients only in a supine posi-

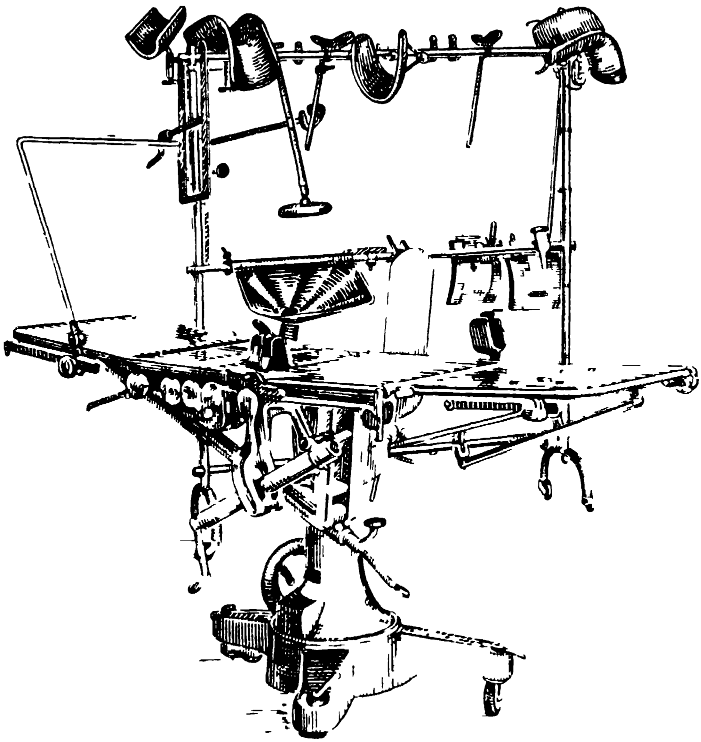


Fig. 18. Modern operating table

tion. To impart other positions to the patient on such tables, bolsters or props are used. Such bolsters 40-60 cm long and 40-60 cm in circumference are placed, whenever necessary, under the patient's shoulders, small of the back and neck.

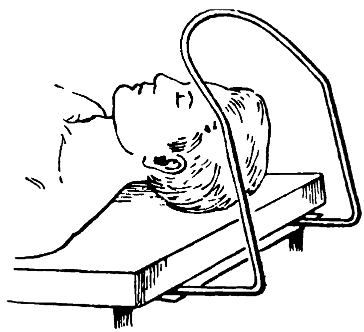
The operating table shown in Fig. 17 is somewhat more complex; it allows for raising the patient's head or entire trunk, for which purpose either the foot or head of the table are raised and fastened in a new position. With the aid of special leg supports it is possible to impart to the patient positions required for operations on the perineum or the lower extremities.

The table shown in Fig. 18 is of a much more complicated design. The table can be raised by pressing on the pedal at the bottom of it. It can be tilted laterally by turning the side wheel.

By manipulating the lever it is possible to change the position of the whole table. If there is a patient on the table, this must be done very carefully, holding the top of the table, otherwise the foot or head of the table will overweigh and the patient may fall off. After attaining the desired tilt, the lever is lowered to fix the table in the new position.

The head of the table may be raised or lowered alone without tilting the rest of the table. The leg supports may be adjusted separately and fixed in any position by means of screws located under them.

The head of the table may also be raised or lowered and fastened with a handle located under the table. A special handle serves to adjust the support for the patient's head. Lastly, there is an arch over the head; this arch is also adjusted by means of screws.



19 Arch over head

The table has several other fixtures which make it possible to elevate different parts of the patient's body.

Patient's position on the operating table. For an operation the patient is usually placed in a dorsal position. If the operation is performed on a table shown in Fig. 17, a small flat cushion is put under the patient's head, while his legs are strapped to the table above the knees. If the operating room is equipped with a table like the one shown in Fig. 18, the patient's head rests on a special support, his legs and arms also fastened to the table. To prevent infection from getting into the operative field, should the patient cough or sneeze, and to prevent him from seeing the wound, if the operation is performed under local anesthesia, a special wire arch covered with a sterile sheet is placed at the head of the table (Fig. 19).

The dorsal position permits of a number of modifications. Thus, for operations on the upper part of the abdomen the upper half of the body may be raised so as to put the patient in a semi-recumbent position. If the head support is placed lower and the head is thereby thrown back, the position will be convenient for some operations on the neck, face and head. Throwing the head back still more facilitates operations on the respiratory tract, nasopharynx, oral cavity, etc.

Some operations on the upper part of the abdomen require a curve in the lumbar region, which is attained either by imparting a double incline to the table or by placing a bolster under the patient's small of the back. For operations on the lower part of the abdomen, especially the minor pelvis, the table is tilted head downward (Trendelenburg's position, Fig. 20). To secure the patient on the table, his legs are flexed in the knees and his shanks are fastened to the table with towels or sheets.

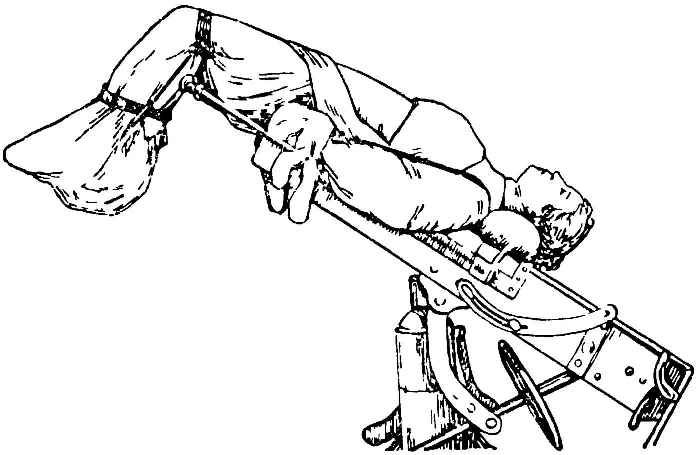


Fig 20 Trendelenburg's position

For operations on the spine, in the region of the buttocks, the posterior surface of the thighs and the occiput the patient is placed in a prone position. On modern tables the patient's head rests on an oval support and anesthesia is administered through a hole in this support.

For most operations on the kidneys the patient is turned on his side. To ensure stability, the leg on which the patient is lying is flexed in the hip and knee joints, while the other leg is extended. To curve the spine and bring the lumbar region forward, bolsters or cushions are placed under the small of the back or the table is given a double incline. For operations on the thorax the patient is put in a lateral position with the upper part of his body raised.

The many operations performed on the perineum and in the anal region necessitate imparting to the patient a position which facilitates access to the perineum. The patient is placed supinely on the edge of the table, his legs flexed in the hip and knee

Fig 21 Perineal position

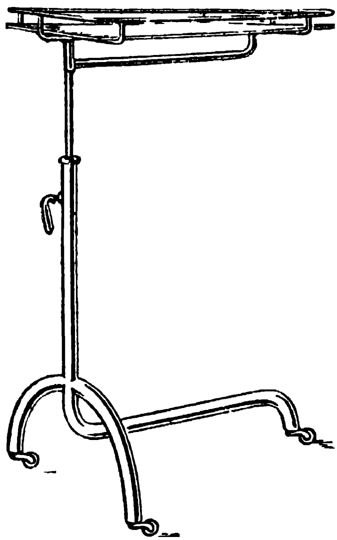


Fig 22 Adjustable instrument table

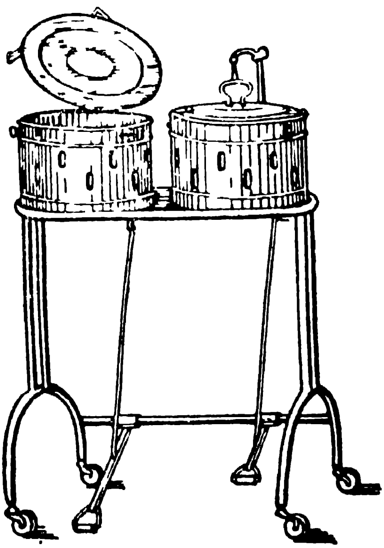


Fig 23 Drum stand

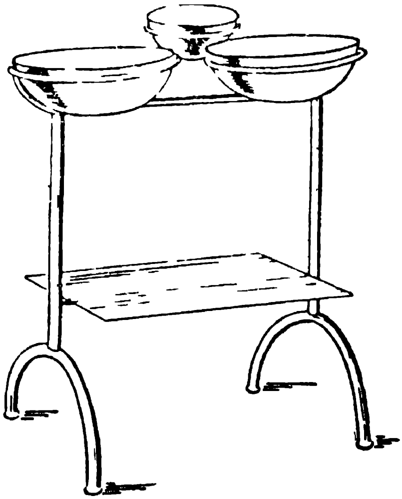


Fig 24 Basin stand

joints and held by two assistants or fastened to special supports (Fig. 21). The surgeon operates while sitting.

The following position is not infrequently used: one of the patient's legs is lowered and the other is extended; during amputations one of the assistants holds the patient's leg.

The operating room must have an additional table serving to support the patient's arm, if the operation is performed on the arm, the scrub nurse's table for the insturments and dressing material, and a small portable and adjustable table (Fig. 22) which is usually placed within easy reach of the surgeon, its top sometimes extending over the patient. The instruments already used by the surgeon are placed on this table.

The drums with sterile linens and dressing material are usually placed on special standards which make it possible to open the drums by pressing a foot pedal (Fig. 23). The operating room must additionally have a small table with instruments, a table with everything necessary for anesthesia (syringe, camphor, caffeine, lobeline, etc.), several stools adjustable in height, enamel basins or refuse pails, and standards with sterile basins for washing the hands (Fig. 24). All the items of the equipment in the operating room must wash easily.

Arrangement of the tables in the operating room and the positions of the surgeon and his assistants. A convenient arrangement of the tables, proper position of the operating table with respect to the lighting and appropriate placement of the assistants facilitate the operation. The head end of the table should be turned so that the operative field is well lighted. Usually the surgeon stands closer to the site of the operation, i.e., on the right side of the patient, facing the patient's head, for operations on the right side of the body (appendectomy, operations on the liver, right breast, right leg or arm), and on the left side of the patient for operations on the left half of the body (left arm or leg, left breast, etc.). For operations on the abdominal cavity above the navel the surgeon usually stands on the patient's right side, and for operations below the navel (gynecological)—to the left of the patient. It is best to have the source of light to the right and somewhat to the back of the surgeon. For operations on the lower part of the abdomen it is therefore more convenient for the patient to lie head to the light and for operations on the upper part of the abdomen—legs to the light; for operations on the back (spine) and in the lumbar region (kidneys) the table is placed parallel to the window.

The positions of the operating team are shown in Fig. 25. The scrub nurse's table is placed on the side opposite the surgeon. The instrument table from which the surgeon can take the dressing material or instruments himself is extended over the patient. The scrub nurse stands at her table and hands the

necessary instruments to the surgeon or prepares them beforehand and places them on the additional table. This enables the nurse to watch the progress of the operation.

If there is only one assistant, he usually stands opposite the surgeon. For operations on the perineum, vagina, skull, etc., the surgeon stands or sits at the end of the operating table, the scrub nurse's table is at a right angle to the operating table, the scrub nurse stands to the side of the table, and the assistants on both sides of the surgeon.

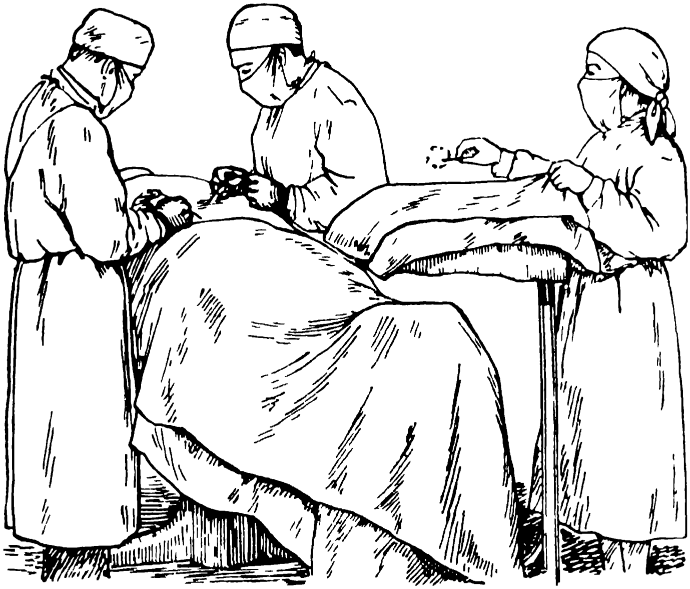


Fig. 25. Operation with one assistant; position of the operating team

Cleaning the operating room. The scrub nurse must know how to clean and put in order the operating room because the cleaning is done under her supervision. All the equipment in the operating room is thoroughly scrubbed with soap and soft brushes. The walls are washed best with hot water. The floor is scrubbed with soap and plenty of water. After the end of the scrubbing the furniture, walls and floor are wiped with clean rags. The window-panes and window sashes are cleaned with a moist rag. The more thoroughly the operating room is cleaned, the less danger there is that infection may be carried into the wound from the air.

The operating room should be thoroughly cleaned as often as possible, at least once in 5-7 days. On cleaning days either no operations should be performed or they should be finished earlier so that enough time may be left for the cleaning. The operating room must not be cleaned directly before an operation.

Dry floor sweeping and dusting with a dry rag in operating rooms and surgical departments in general are strictly prohibited.

INSTRUMENTS

Instruments and surgical apparatus are the most expensive and at the same time most easily spoiled equipment of a surgical department. Thorough care of the instruments is particularly important not only because it helps to preserve them, but also because work with bad instruments considerably complicates operations and may lead to grave, even fatal consequences for the patient (for example, to bleeding, if a faulty hemostatic clamp slips off, or spilling of the gastrointestinal contents into the abdominal cavity, if a defective intestinal clamp gives away).

Thorough care of the instruments and equipment, as well as their maintenance in good order, are the most important duty of the scrub nurse.

The instruments may be divided into the following groups:

a) instruments for operating on soft tissues;

b) instruments for operating in the abdominal cavity—on the stomach and intestines, biliary tract, etc.;

c) instruments for operating on the bones of the skull, spine and extremities;

d) instruments for operating on the thoracic organs—the heart and lungs;

e) instruments for operating on the urinary tract—kidneys, urinary bladder and urethra;

f) instruments for operating on the rectum.

We are omitting the instruments for ophthalmological, gynecological and otolaryngolocial operations since these are described in special manuals.

INSTRUMENTS FOR OPERATING ON SOFT TISSUES

1. *Cutting instruments.* These include scalpels of all types and sizes—bellied, pointed and bulbous-end (Fig. 26). They are the main cutting instruments. It is extraordinarily important for the surgeon to have sharp scalpels. Scalpels become blunt not so much from work as from careless handling, for example, when

they are kept together with other instruments, their blades not covered with cotton, or when they are carelessly thrown about. Scalpels become very blunt during boiling, but for purposes of asepsis this cannot be avoided. To preserve scalpel blades, they are covered with cotton.

It is very important to choose suitable and sufficiently sharp scalpels before the operation. They must be tested on the fine

Fig 26 Bellied, pointed and bulbous-end scalpels

Fig. 27. Amputation knife

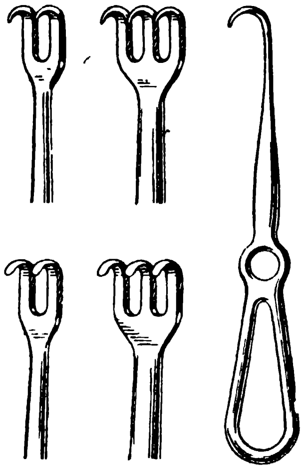


Fig. 28. Surgical pronged retractors—sharp and blunt

hair of the forearm to see whether they shave the hair or glide over it. A pointed scalpel must have a particularly sharp point, a bellied scalpel—a sharp middle of the belly. The surgical personnel must not only take care of the scalpels but must also sharpen them. It is very easy to learn to sharpen scalpels; beginners should use old and less valuable instruments. Sharpening requires a soft whetstone and hone; the whetstone should be moistened with water and the hone coated with vaseline oil.

The cutting instruments also include knives for tenotomy and amputation knives (Fig. 27): one-sided—for thighs and upper arms and two-sided—for the shanks and forearms.

2. A large number of different *retractors*—one-, two- and three-pronged, sharp and blunt (Figs 28 and 29), deep-tissue retractors (Fig. 30), etc. Sharp retractors are used wherever the tissues are dense and there is no danger of injuring the vessels or tissues, for example, for drawing the skin apart. Blunt and, more frequent-

ly, deep-tissue retractors are used in separating deeper tissues, especially near large vessels.

3. Dissecting (Fig. 31) and dressing *forceps* (Fig. 32). For operating on delicate tissues, especially for grasping blood vessels, intestinal loops, etc., dissecting forceps is used; grasping denser tissues, especially for holding skin edges during suturing, requires dressing forceps. Dressing forceps differs from dissecting forceps in that it has fine teeth at the end of the jaws. The scrub nurse must have separate dressing forceps to hand silk to the surgeon.

4. Hemostatic forceps with wide blunt ends (*Péan's* forceps, Fig. 33) and with narrow ends supplied with fine teeth (*Kocher's*

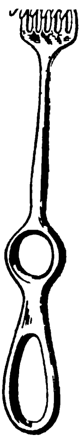


Fig. 29. Four-pronged blunt retractor

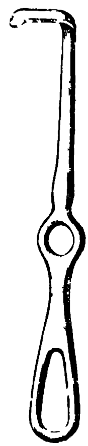


Fig. 30. Deep-tissue retractor

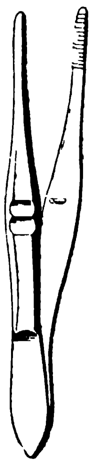


Fig. 31. Dissecting forceps

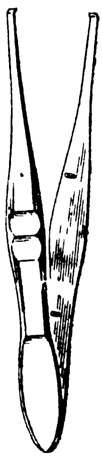


Fig. 32. Dressing forceps

forceps, Fig. 34). Kocher's forceps is more convenient for grasping the vessels in dense tissues (skin) because it does not slip off so easily; wherever the tissues are soft and delicate (for example, in venous plexuses) it is best to use Péan's forceps because it is less traumatising.

There are also other types of hemostatic forceps, for example, with long and blunt ends (Fig. 35), and stronger forceps for grasping large sections of tissues together with vessels for the subsequent mass ligation of vessels together with tissues.

5. *Scissors* (Fig. 36) are used for dividing deep tissues (aponeuroses, fascia, muscles, etc.). Straight pointed scissors with a button (*b*) as well as scissors with curved blades (*Cooper's* scissors Fig. 36, *a*) are the most convenient. They are also used for enu-

cleating tumours. It is very important that Cooper's scissors should open and close easily and cut well with their ends. Lastly, scissors are used for cutting bandages.

6. Bulbous-end *probes* and *directors* (Fig. 37) are used for exploring the depth and course of fistulas.

7. *Needles* (Fig. 38). There are needles of different sizes. Surgical needles have an automatic eye (Fig. 39) to be threaded more quickly and easily.

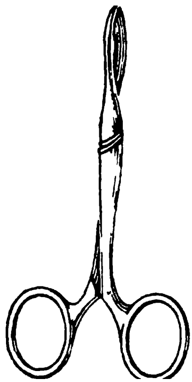


Fig. 33. Péan's hemostatic forceps

Fig. 34. Kocher's hemostatic forceps

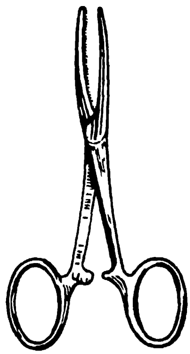


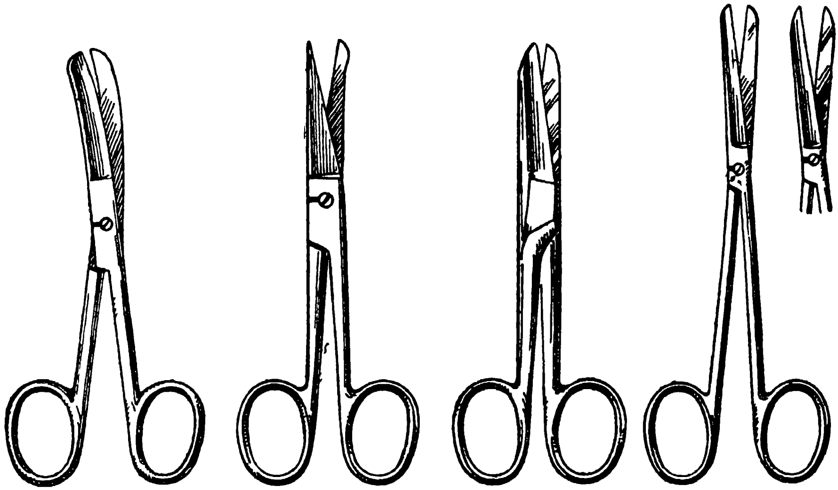
Fig. 35. Billroth's hemostatic forceps

Needles are also distinguished by their curves. Deep work requires greatly curved needles, whereas for suturing more superficial tissues, especially the skin, needles with lesser curves may be used. Large needles are convenient for preliminary suturing of the skin to avoid hemorrhage during operations on the skull. Lastly, needles have different cross-sections. Three-sided needles are most frequently used. They have cutting edges and therefore easily pierce even dense tissues (aponeuroses, tendons and the skin). Their essential shortcoming is that they can injure the vessels, for which reason round needles, which will be discussed below, are employed for suturing internal parenchymatous organs and the intestines. Some surgeons use no needle holders, but hold the needles in their hands, in which case longer needles, straight or with curved ends, are more convenient.

Mention must also be made of different needles with handles. The simplest of these is *Deschamps'* needle (Fig. 40). It is used for tying off vessels alone or together with tissues. Absence of an automatic eye is its shortcoming. Deschamps' needle has to be threaded before it is handed to the surgeon.

The needles are distinguished as right- or left-hand needles according to their curves.

8. *Needle holders.* There are different types of needle holders (Fig. 41) distinguished mainly by the lock. The needle is grasped with the needle holder held in the right hand. To release the needle it is necessary to compress the needle holder, in which case the



a) b)

Fig. 36. Scissors—Cooper's (a) and straight (b)

Fig. 37. Bulbous-end probe

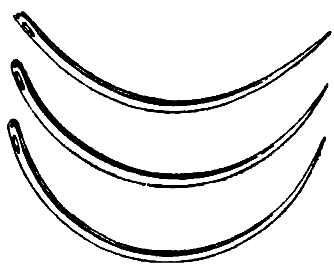


Fig. 38. Curved needles

Fig. 39. Automatic eye of surgical needle

Fig. 40.
Deschamps'
needle

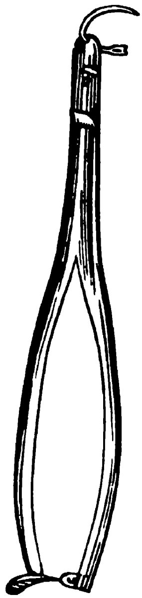


Fig. 41.
Needle
holder

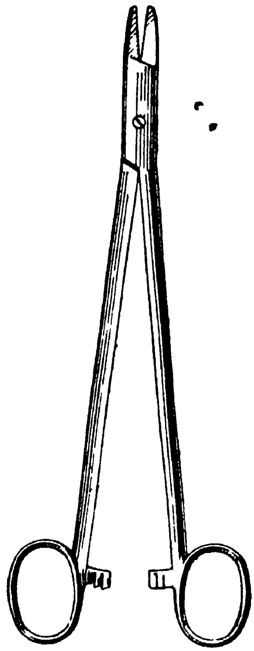


Fig. 42.
Gynecological
needle holder

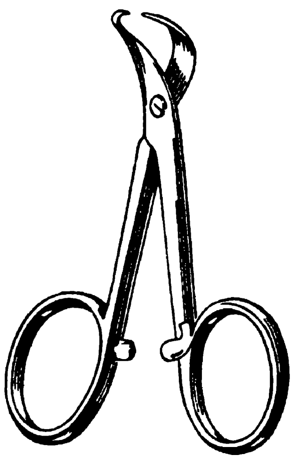


Fig. 43. Towel clip

Fig. 44
Double-ended
retractor

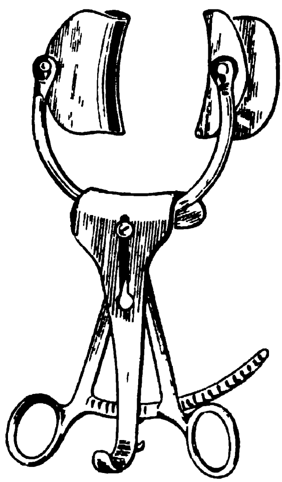


Fig. 45. Self-retaining retractor

teeth of the lock are disengaged and the needle holder releases the needle. The shortcoming of this needle holder is that its teeth wear off very quickly and the lock goes out of order.

The *gynecological* needle holder shown in Fig. 42 is convenient for deep suturing. It opens and closes like the hemostatic forceps, because it has a similar lock.

9. To fasten towels to the wound margins *towel clips* (Fig. 43) are used.

INSTRUMENTS FOR LAPAROTOMIES

These instruments are intended for operations in the abdominal cavity.

1. In addition to the instruments enumerated in the preceding paragraphs, such operations also require abdominal *retractors.* Simple double-ended retractors (Fig. 44) are the most convenient. Self-retaining retractors (Fig. 45) are also employed.

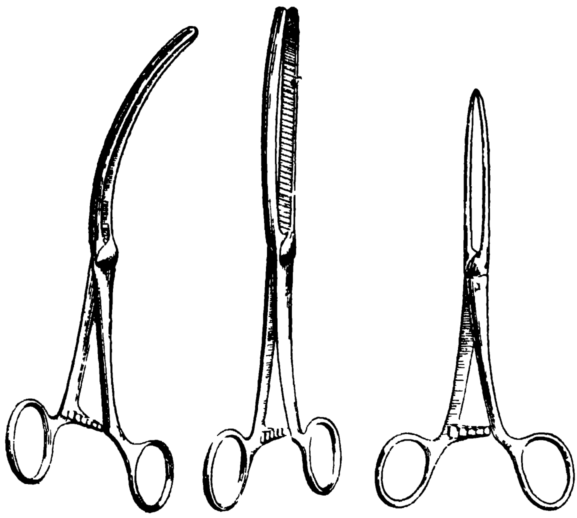


Fig. 46. Intestinal forceps

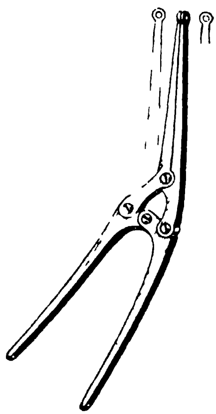


Fig. 47. Payr's clamp

2. Before incising the stomach or intestines special clamps or forceps are applied to them to prevent their contents from running out. These clamps and forceps are divided into two large groups. The first group includes the clamps and forceps which do not injure the intestinal wall (Fig. 46) and are applied somewhat away from the incision; the other group of gastrointestinal clamps and forceps differs from those of the first group in that in grasping the stomach and intestines they crush them (Fig. 47). Naturally, such clamps and forceps may be applied only to the parts to be

removed or the boundary between the diseased and healthy tissue. Gastric clamps are larger and more massive than intestinal clamps.

3. To drain the exudate (*ascites*), *trocars* (Fig. 48), straight and curved, are used.

4. Since every operation on the gastrointestinal tract requires ligating or suturing intestinal or gastric walls, needles play a particularly important role. Usually, round, straight and curved

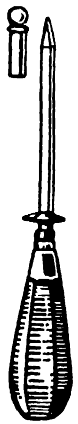


Fig. 48. Trocar

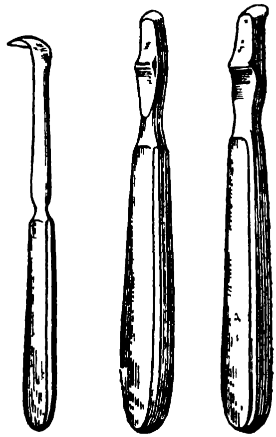


Fig. 49. Raspatories

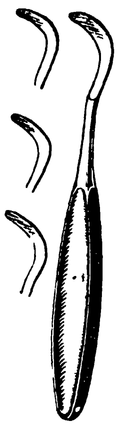


Fig. 50. Elevator

needles are employed. They are preferable because the sutures made by them do not cut the tissues, and they are less injurious to the intestinal wall and its vessels. Fine interrupted or continuous sutures (silk linen or catgut) are usually made.

5. In operations on the liver and biliary tract speculums are used for holding the liver, probes—for exploring the bile ducts, etc.

INSTRUMENTS FOR BONE OPERATIONS

1. To separate and remove the periosteum from the bone differently-shaped *raspatories* (Fig. 49) are used.

2. *Elevators* (Fig. 50) are used partly for removing the periosteum, but mainly for elevating and fixing the bones. They are made with curves, depending on their purpose.

3. *Bone chisels.* The chisels may be straight (Fig. 51) of different length, width and thickness (large, small, intermediate, etc.), depending on the purpose for which they are used. A tapering chisel used for cutting bone is called an *osteotome* (Fig. 51). A chisel may be grooved in which case it is called a gouge (Fig. 52).

4. Mainly metal, but sometimes also wooden, *mallets* (Fig. 53) are employed.

5. For scraping bone cavities strong sharp bone *curets* of different sizes and shapes with handles (Fig. 54) are employed.

6. To saw bones various *saws* are used. Blades of different width may be inserted in a special frame (bow-type saws, Fig. 55); in a well-constructed frame the blades may be fastened at any angle

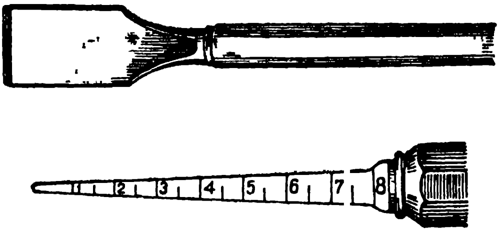


Fig. 51. Chisel (top) and osteotome (bottom)

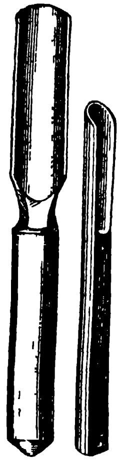


Fig. 52. Gouges

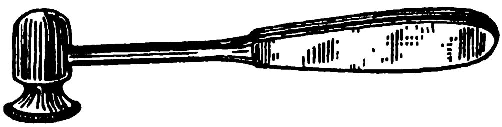


Fig. 53. Mallet

Fig. 54. Curet

to the frame. Hand-type saws (Fig. 56) are of a simpler construction.

A wire saw is not infrequently employed (Fig. 57). The wire is placed around the bone, the handles are attached and the bone is sawed by drawing the saw to and fro. These saws are weak and often break, for which reason a few of them are always kept in reserve.

7. For grasping bone *sequestrum forceps* (Fig. 58) and various *bone-holding* forceps are used.

8. For cutting off small bones and for nipping off sharp ends of large bones various types of *bone-cutting forceps* are employed.

These include Liston's forceps (Fig. 59) of different sizes and with various curves. Luer's bone-cutting forceps is (Fig. 60) also a very important instrument. It is also made in different sizes and with different curves. With the aid of this forceps large pieces of cranial bones can be removed by nipping off their edges.

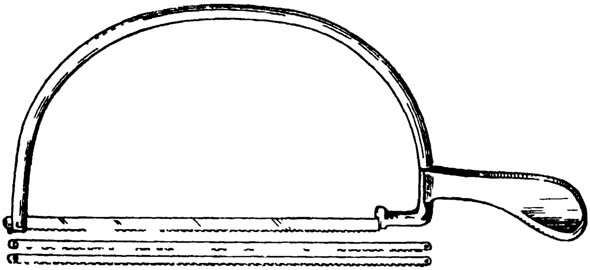


Fig. 55. Bow-type bone saw

Fig. 56. Hand type bone saw

Fig. 57. Wire bone saw

Lastly, Dahlgren's forceps (Fig. 61) is used for cutting the cranial bones. This forceps is a very necessary instrument because it makes it possible to cut considerable sections of the cranial bones without particular difficulty.

9. To unite bones with wire it is often necessary to make holes in them. This is done with the aid of different instruments, the *perforator* (Fig. 62) being the simplest. Turning the handle of this instrument drives it into the bone. As soon as it pierces the bone,

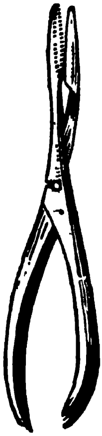


Fig. 58.
Sequestrum
forceps

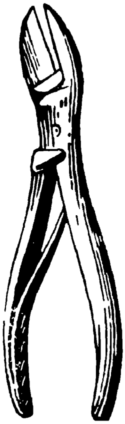


Fig. 59.
Liston's
bone-cut-
ting gouge
forceps

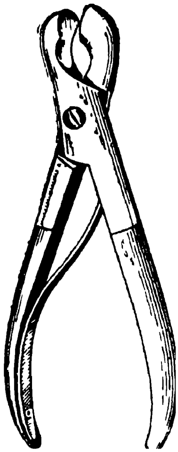


Fig. 60.
Luer's
bone-cutting
gouge forceps

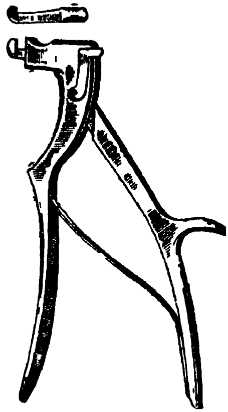


Fig. 61.
Dahlgren's
gouge forceps

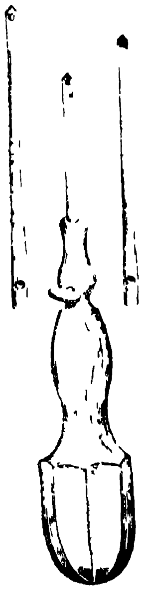


Fig. 62.
Perforator

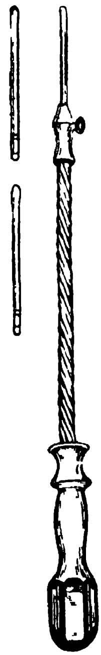


Fig. 63.
Drill

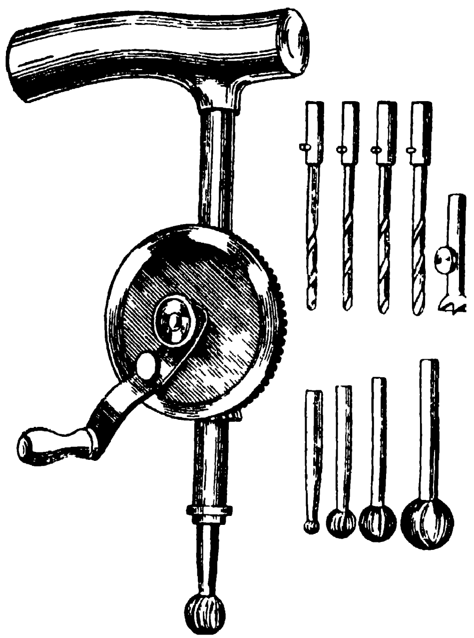


Fig. 64. Burr with bone-drilling brace

wire is put through the hole near its tip and is threaded through the bone as the perforator is being withdrawn. A *drill* (Fig. 63) is a more complex instrument. It is rotated when its middle part (sleeve) is rapidly moved along its long axis.

10. Bone fragments are sometimes united by pins of different length and diameter, and most frequently by plates of various sizes and shapes.

11. For operations on the skull (trephining) it is necessary to make an opening in the cranial bone. This is done with the aid of burrs with bone-drilling braces (Fig. 64), by turning the disk of the instrument. Improved modern burrs are driven by an electric motor.

12. In tracheotomies tracheotomy tubes (Fig. 65) and tracheal dilators (Fig. 66) are used.

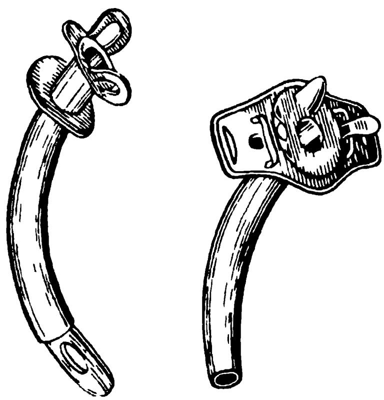


Fig. 65. Tracheotomy tubes

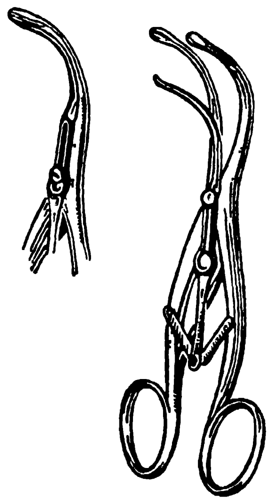


Fig. 66. Dilator for the trachea

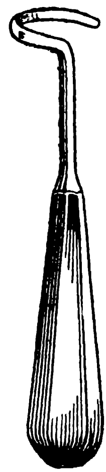


Fig. 67. Rib raspatory

INSTRUMENTS FOR OPERATIONS ON THE LUNGS, ESOPHAGUS AND HEART

1. To remove the periosteum from the ribs, a rib raspatory (Fig. 67) is employed in addition to the usual raspatories.

2. To cut ribs, rib-cutting shears of different types—from the simplest (Fig. 68) to the most complex—are used.

3. Self-retaining rib retractors (Fig. 69) serve to hold open the wounds in the thoracic wall.

4. To hold the lungs, lung clamps are employed. To suture

bronchi and ligate its vessels, complex automatic sewing apparatus using metal (tantalum wire) clips have been devised.

5. For intracardiac operations many special instruments (valvulotomes, forceps, etc.) are used, depending on the nature of the operation.

Fig. 68. Rib-cutting shears

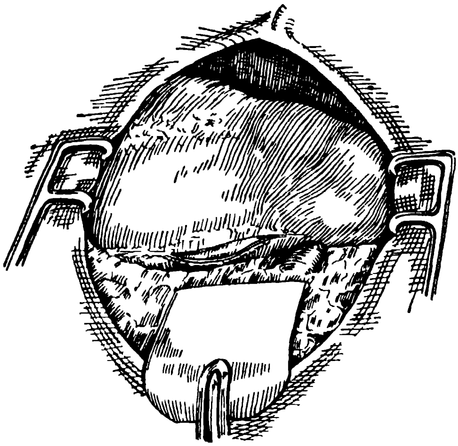


Fig. 69. Rib retractor

INSTRUMENTS FOR OPERATING ON THE URINARY TRACT

These instruments are very diverse and complex.

1. To begin with, they include various kinds of retractors employed for operations on the kidneys and the urinary bladder.

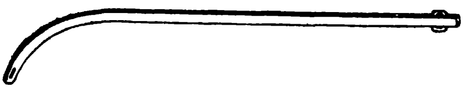


Fig. 70. Metal catheter

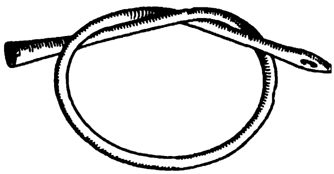


Fig. 71. Rubber catheter

2. Special *pedicle clamps* are used for grasping and holding the renal pedicle.

3. Various *dilators* and *bougies* are employed for dilating the urethra; *urethrotomes* are used for dividing urethral strictures.

4. *Catheters*—rigid, metal (Fig. 70), semi-soft silk and soft rubber (Fig. 71)—are used for draining the urine.

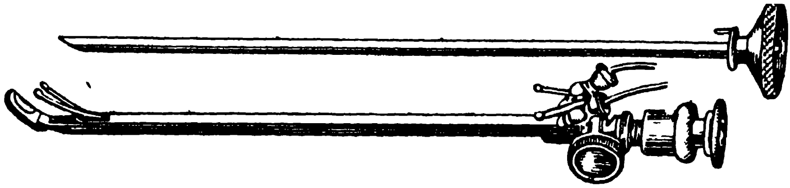


Fig. 72. Cystoscope

5. *Cystoscopes* are employed for examining the urinary bladder. Catheterisation cystoscopes (Fig. 72) are used for introducing catheters into the ureters (Fig. 73).

INSTRUMENTS FOR RECTAL OPERATIONS

1. These include different speculums which make it possible to operate on the rectum after its dilation (Fig. 74).
2. To grasp hemorrhoids *Luer's* hemorrhoid *forceps* (Fig. 75), etc., are used.
3. To examine the rectum, a *rectoscope* is employed.

Of the other instruments mention must also be made of *spatulas* and *pans* for pus (Fig. 76).

CARE OF INSTRUMENTS

After operations or dressings the instruments should be thoroughly scrubbed with a brush and soap in a basin or under a tap, while dismountable instruments (scissors, Péan's and

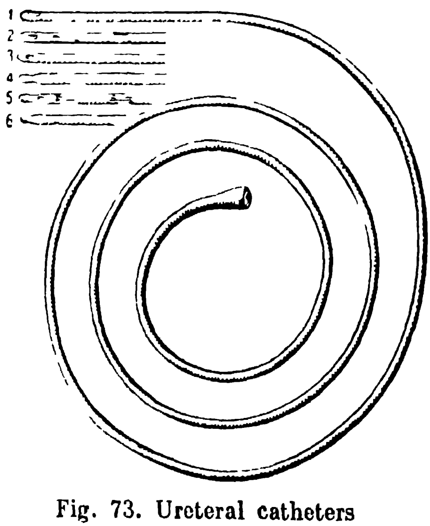


Fig. 73. Ureteral catheters

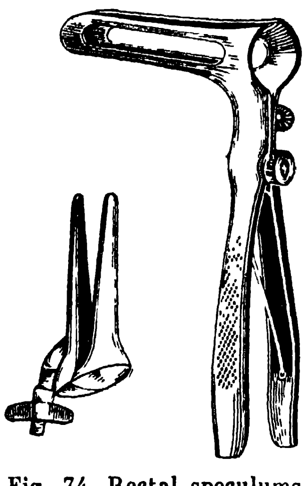


Fig. 74. Rectal speculums

Kocher's forceps, etc.) should first be taken apart. After scrubbing, the instruments should be boiled, carefully dried and the locks lubricated with vaseline oil.

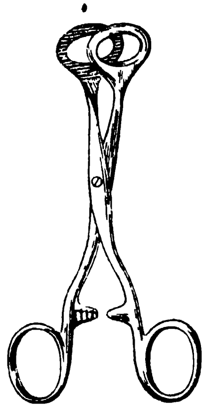


Fig. 75.
uer's forceps

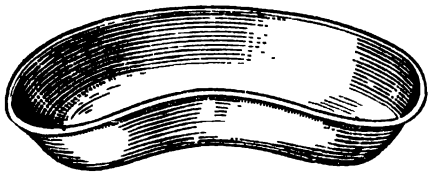


Fig. 76. Pan for pus

In assembling scissors, forceps, etc., care should be taken not to join the wrong halves, or they may become unfit for use. As a rule, each instrument has its number marked on the inside.

DUTIES OF THE SCRUB NURSE

If there are several scrub nurses, the duties among them should be distributed so that one of them (the head nurse) should be responsible for the general organisation of the surgical work, the work records and supervision of the other workers of the surgical department, while the other scrub nurses should be in charge of sterilisation, linens and instruments, should prepare the suture material (silk, catgut, etc.), and see to it that there is enough sterile dressing material, linens and necessary drugs. Such assignment of duties to the nurses, making each one responsible for a certain part of the work, is quite expedient. Scrub nurses hand the instruments to the surgeon and see to it that everything is ready for the operation in which they take part. Less important work—preparation of basins, bringing drums with linens and dressing material into the operating room, boiling the brushes for hand-scrubbing, etc., may be assigned to experienced orderlies, but under the constant control of a scrub nurse. The suture material is prepared and the instruments are boiled under supervision of a scrub nurse.

Thus, scrub nurses are in charge of the rooms of the surgical department and all of its property and equipment; they see to it that the equipment is kept in good order and is replenished and replaced in good time; they are also responsible for the hygienic conditions of the rooms and provide all that is necessary for operations.

The scrub nurse must prepare before the operation everything that is required for the surgical work: iodine, alcohol, a mercury bichloride solution and a hot physiologic saline solution; she must also see to it that all the apparatus are in good order.

To avoid any misunderstanding, it is desirable that a list of instruments necessary for the most typical operations should be made and given to the surgeon for approval. Such a list is placed in the instrument cabinet and is used for selecting instruments in the evening preceding the operation. This guarantees that nothing will be omitted. For atypical operations the sur-

geon should be consulted, as to the instruments he will need, beforehand.

Thus, the scrub nurse must make sure in the evening what operations would be performed the following day and in what order. The list of operations is usually tacked on a special board near the operating room.

The duties of the scrub nurse include assistance during operations. This assistance is very essential for a calm and uneventful course of the operation, as well as for its outcome. Particularly important is careful observance of the rules of asepsis, for which purpose the scrub nurse must closely watch all members of the operating team and all persons present at the operation (students, interns, physicians from other departments, etc.). If the operating surgeon fails to notice some violation of the rules of asepsis made by himself or his assistant, the scrub nurse should call his attention to it.

Fig. 77. Scrub nurse's uniform

To begin with, the nurse must strictly observe the rules of asepsis and carefully avoid any contact with pus (pus-collecting trays, soiled bandages, etc.). On the day of the operation she must not do any dressing; on the day preceding operations she must wear gloves when dressing wounds. If the scrub nurse has soiled her hands with pus or has been in contact with contagious patients (erysipelas, scarlet fever, etc.), or if she harbours some purulent infection herself, she must warn the surgeon about it. Of course, the scrub nurse must strictly observe the rules of personal hygiene. In preparing for an operation she must cut her fingernails short, put on a clean gown and thoroughly cover her head with a kerchief. During the operation the scrub nurse must wear rubber gloves and a gauze mask (Fig. 77).

Usually, the surgeon should have at least two assistants for all major operations.

The duties of one of them consist in direct assistance to the surgeon—encircling the operative field with sterile linen (Fig. 78), wiping off the blood, clamping the bleeding vessels, holding the retractors with which the edges of the wound are separated, removing the hemostats after ligation of the vessels, maintaining approximation of the skin edges while the surgeon ties the suture,

etc. He must also see to it that no instruments or tampons are left in the wound. The duties of this assistant are not infrequently carried out by a scrub nurse who must have enough experience, must know the course of the operation, etc.; but strict observance of the rules of asepsis, well-scrubbed hands and the ability to keep

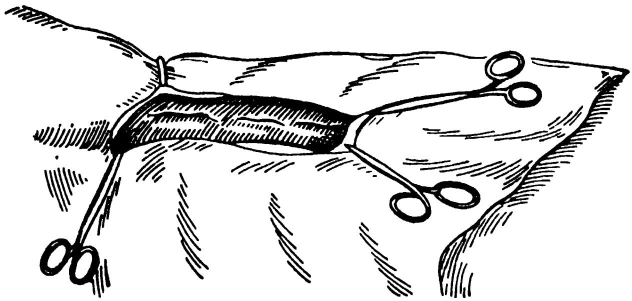


Fig. 78. Draping the operative field

them sterile throughout the operation are the most important thing just the same.

The main duty of the scrub nurse during the operation is handing the instruments to the surgeon. Since the scrub nurse must separate and assort the instruments, she must be ready for operations 15-20 minutes ahead of the surgeon.

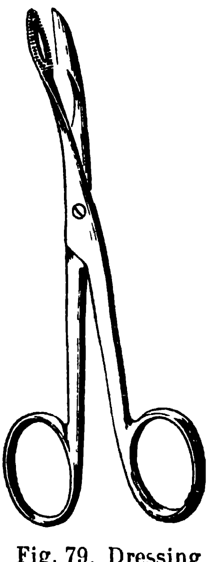


Fig. 79. Dressing forceps

Before handing an instrument to the surgeon the nurse must make sure that it is in good order, otherwise a defective hemostatic forceps, for example, may slip off a vessel, upset the whole course of the operation, and jeopardise the patient's life.

The instruments are handed to the surgeon in two ways: the nurse either puts the necessary instrument directly into the surgeon's hand or she places within his reach the instruments which he may need at the moment. The first method requires good contact with the surgeon and familiarity with his working habits. Mistakes may occur, i. e., the nurse may hand the surgeon the wrong instrument. Therefore, the second method, when the nurse sorts the instruments and places them within the operator's reach, is more convenient, especially during the initial period of the nurse's joint work with the surgeon. In this case it is best to place in the very beginning of the operation an additional table with a

scalpel, forceps, hemostats, gauze towels and balls within easy reach of the surgeon's right hand.

The suture material can also be prepared beforehand and placed on the table. Of course, this method does not exclude handing some instrument directly to the surgeon upon his request. At any rate, whether the first or second method is used, the surgeon must immediately get all he needs. The surgeon must never be allowed to waste his time. Only good and fast teamwork may considerably reduce the operating time, which is very important.

When handing an instrument directly to the surgeon, the scrub nurse must be careful not to injure his hand. For example, a scal-

Fig. 80. Handing a scalpel to the surgeon

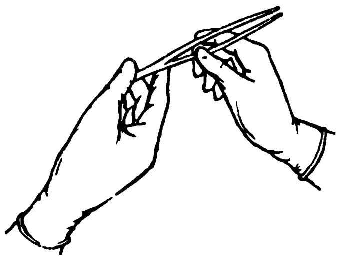


Fig. 81. Handing a forceps to the surgeon

pel is handed to the operator handle forward, the sharp edge of the blade downward and the blade covered with the nurse's hand (Fig. 80). The other instruments—forceps (Fig. 81), scissors (Fig. 82), hemostats, etc., are also handed to the surgeon handle forward.

If an instrument has touched some unsterile object, while being handed to the surgeon, it is necessary immediately to inform him about it, lay the instrument aside and order one of the nurses in the operating room to boil it, or replace it with another instrument. Blood-spattered instruments should be washed in a soda solution before the operator uses them again. If instruments become infected during the operation, for example, an intestinal operation, they must be put away (in a tray or basin).

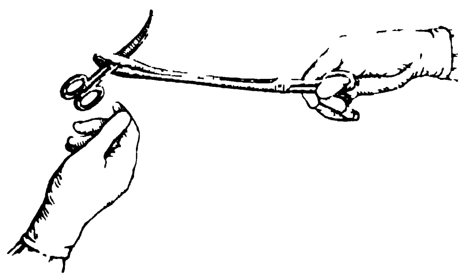


Fig. 82. Handing a scissors to the surgeon

Handing suture and ligature material to the surgeon requires considerable skill. The sutures and ligatures are left in the tis-

sues and their slightest contamination may infect the wound. The nurse must therefore never touch these materials with her hands.

To hand the suture material to the surgeon, the scrub nurse must set apart two dissecting forceps and a scissors. The silk and linen thread may be left in the pan in which it was boiled for the operation. The suture material is taken out without touching the edges and walls of the pan.

The end of the silk thread is grasped with a forceps, is pulled, unwinding the spool, until the necessary length has been unwound, and the thread is cut (Fig. 83). If the spool does not unwind and is lifted by the thread, it must be held in place with the scissors. The thread must not be cut too close to the spool, or it will be difficult to find its free end.

The spool with silk or catgut may be placed on a sterile towel with the

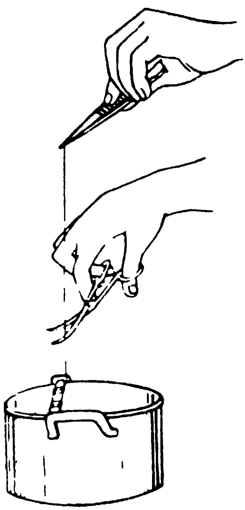


Fig. 83. Cutting off a ligature

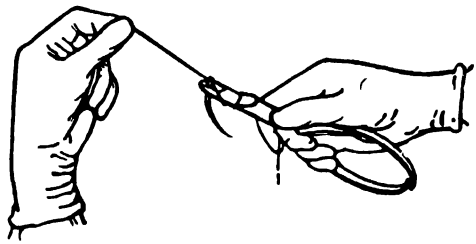


Fig. 84. Threading a needle grasped by a needle holder

aid of a dressing forceps and then the requisite length of thread may be cut off. Before using catgut the entire skein is unwound. Silk thread or catgut strands are used in surgery for ligatures and sutures. In the former case it is handed to the surgeon with a forceps in lengths of 15-20 cm, according to request; in the latter they must be handed already threaded through the eye of a needle held in a needle holder. Threading the needle and handing it to the surgeon is an essential part of thescrub nurse's duties. The scrub nurse must learn to thread needles properly and quickly so that the surgeon may not have to wait. Needles with ordinary eyes are now very rarely used; they have been replaced with needles having automatic eyes (see Fig. 39). To thread a needle (Fig. 84) it is enough to place the thread on the lock and pull it.

In handing the needle holder with the needle and thread to the surgeon the nurse must see to it that the thread does not touch anything unsterile and that the surgeon does not prick himself or the nurse with the needle. The needle holder should be handed to the surgeon as shown in Fig. 85. The dressing material and tampons should be folded before they are handed to the surgeon so that they may not hang over and come in contact with anything unsterile. The instruments should be counted before and after the operation. Each gauze towel should have a piece of tape fastened to it. It should be noted that even these measures do not serve as a guarantee against leaving tampons or instruments in the wounds, for which reason they must be very carefully watched during the operation. No small pieces of gauze or small instruments (forceps, hemostats), not needed at the given moment, should be allowed near the wound, especially during cavitary (abdominal, thoracic) operations; the large gauze compresses inserted in the cavity should be clamped to the drapes.

Fig. 85. Handing a needle holder to the surgeon

In cases in which the surgeon does not have a third assistant he may, at some time during the operation, need the assistance of the scrub nurse; for example, he may ask her to hold the retractors.

Before each new operation all the instruments, even those that were not used, and the suture material are *resterilised* and the instrument table is set up anew.

During the operation there must be no idle talking and what is necessary in the course of the work should be said briefly. No wrangling with the operator is allowed because this may interfere with the operation. All explanations should be postponed till the end of the operation.

The scrub nurse bears a tremendous legal and moral responsibility for the life and health of the patient; she shares this responsibility with the surgeon. Her work must be faultlessly efficient and accurate and she must have a highly developed sense of duty and responsibility for her work. The nurse must be frank; she must not conceal her ignorance or mistakes. She must be a model of discipline and irreproachable in everything concerning asepsis. An experienced nurse will never touch unsterile things with scrubbed hands or take sterile things with unscrubbed hands even mechanically.

AUXILIARY ROOMS OF THE SURGICAL DEPARTMENT

. Well organised surgical departments have special *scrub-up rooms* with washstands and a stock of boiled brushes; these brushes should be handled with the aid of a dressing forceps. Scrub-up rooms are frequently equipped with special sinks for scrubbing instruments. These rooms must not be cluttered up with furniture; nor should the instrument cabinets be placed in them because of the excessive humidity which may rust the instruments.

The *sterilisation room* contains autoclaves which are large enough to provide the surgical department with the necessary amount of sterile dressing material and linen. The autoclaves are heated by electricity or steam from a special boiler room. In surgical departments equipped more modestly the autoclaves are heated with gas or primus-stoves.

Instrument sterilisers are another indispensable accessory of this room. Electric or steam sterilisers are considered the best, but if these are lacking sterilisers heated with gas or primus-stoves are used.

Special *instrument and storage rooms* are set apart for the instruments, linens and dressing material, although the instruments and clean linens for the operations may be kept and the material prepared in the same room. The dressing material and clean linens are kept in a locker (soiled linens must be immediately removed from the operating division of the surgical department). Gauze is cut for sterilisation on a special table. To keep the instruments from spoiling, the storage room must be absolutely dry and must not communicate with the scrub-up or sterilisation rooms, but must be rather isolated. The instruments must be laid out in special glass cabinets (or suspended) preferably in groups (see the chapter entitled *Instruments*). The instruments should be brought to the storage room already scrubbed and dried. The instruments required for an operation are selected in the storage room and are then sent to the sterilisation room.

The same rules of cleanliness must be observed in all these auxiliary rooms as in the other parts of the surgical department.

DRESSING ROOMS AND WARDS

In addition to the rooms necessary for all the other departments (sanitation room in which those admitted to the hospital are given the first sanitary treatment, dining-room, pantry, lounge, wards, bathrooms and toilets), the surgical department includes an operating division and one or several dressing rooms.

Dressing room. Dressings may be made in any room which is not particularly cluttered up. However, this work can be properly organised only in a special dressing room set up along the same lines as the operating room.

The dressing room must have the following equipment: a dressing table, a table for the instruments and dressing material, several stools for patients, a desk for making entries in the case histories, a washstand with hot water, a basin for used bandages, a container with boiled brushes and a receptacle for soap, bottles with disinfecting solutions, drums with sterile material. trays with clean instruments, trays for used instruments, pus-collecting trays, jars and bottles with ointments and disinfecting liquids (for example, sterile vaseline, benzine, hydrogen peroxide). All the items of the equipment should wash easily and the trays for the instruments should readily sterilise.

The list of instruments necessary for every dressing room is small, but extensive and intensive work requires a large number of these instruments.

The following instruments are the most necessary: 1) dressing and dissecting forceps to grasp the material, remove the sutures and tampons, and hold the gauze for wiping the skin around the wound; 2) straight and curved (Cooper's) scissors to trim tampons, remove sutures, etc., as well as special scissors to cut bandages; 3) deep tissue retractors to separate the lips of wounds; 4) Péan's and Kocher's hemostatic forceps to control possible hemorrhages during dressing; 5) needle holder with needles for suturing; 6) spatulas to apply ointments; 7) bulbous-end probes and directors; 8) scalpels for incisions; 9) dressing forceps to handle instruments and dressing material; 10) catheters and

bougies, drains, etc. In addition to these instruments, the dressing room should have a tourniquet, Esmarch's can, stomach tube with funnel, rubber balloon, steriliser to boil the instruments, footboard for the table, special steriliser to boil the syringes and needles for subcutaneous and intravenous injections. The following drugs should be on hand: camphor, caffeine, valerian drops, ammonia water, chlorethyl, ether, and all the substances required for dressings.

Removing dressings. In changing dressings the latter should be removed carefully so as not to injure the wound. If a dressing adheres firmly, it should be soaked off with hydrogen peroxide. The nurse must see to it that all dressings soiled with pus should be immediately put in a special basin and that, if pus exudes from the wound, it should not drop on the table, the floor or any of the surrounding objects; the pus must be collected in a tray and taken out of the room. The nurse should also be careful not to contaminate her hands with pus. The dressings impregnated with pus should be burned.

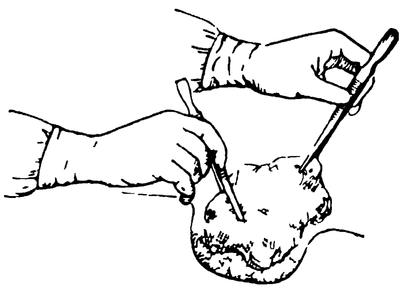


Fig. 86. Dressing by means of forceps (instrumentally)

Hand-scrubbing takes about ten minutes and each dressing—an average of about five minutes, for which reason the nurse can make only four dressings an hour if she contaminates her hands during each dressing.

Recognising the necessity for saving time and the difficulty of completely disinfecting the hands (hands contaminated with pus cannot be considered clean even after scrubbing for 10-15 minutes), the modern dressing rooms practise so-called *instrumental dressing* (Fig. 86). The dressings are removed, the pus is wiped off, the wound is cleaned and new dressings are put on with the aid of forceps. The nurse does not touch the wound or the dressing material with her hands. This requires a large number of forceps and their boiling after each dressing. Reception rooms, dispensaries and first-aid stations should have sterile dressing material and boiled instruments in readiness so that the first dressing may be made immediately upon the arrival of the patient without any waste of time. All the work in the dressing room must be done with rubber gloves.

Wards. The wards must be spacious, the windows taking up at least one-sixth of the floor area. It is advisable to have preoperative and, what is especially important, recovery wards

or departments where the patients can be kept under particularly careful observation during the first days after the operation. For the feeble and moribund patients, as well as for those whose dressings spread an unpleasant odour (patients with enuresis, burns, etc.) it is desirable to have smaller (for two beds) or individual wards. Patients suspected of harbouring infection have to be isolated. The wards for operated patients must be particularly clean, light and well ventilated, and must have easily washable floors; they must not be encumbered with superfluous, especially upholstered furniture. The temperature should be maintained at about 17-19°C. The entire equipment of the wards must consist of ordinary beds or beds with one or two breaks in the frame (Fig. 87), bedside tables and stools. Beds with springs and mattresses are the most convenient. Washstands with hot and cold water are desirable. The beds should be placed so that the patients are not discomforted by the light. Care must be taken to protect the patients from draughts to which they are very sensitive, especially after the operation. The beds are placed, if possible, not along walls, but at a right angle to them.

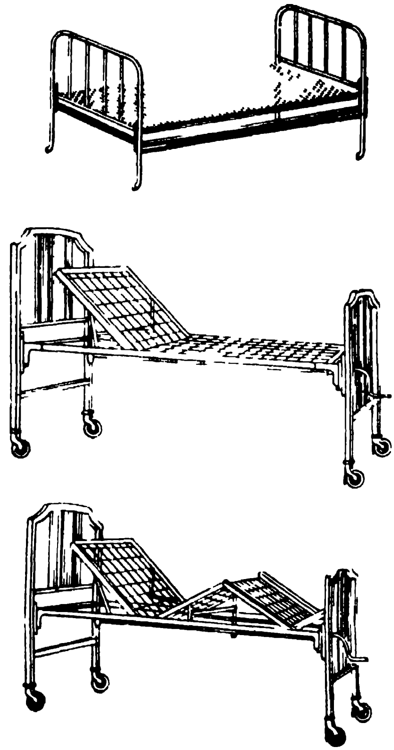


Fig. 87. Beds

ANESTHESIA

The works of I. P. Pavlov and his pupils offer the best insight into the essence of pain sensations and their effect on the whole human organism. Any stimulation (mechanical, chemical or electric) of the special apparatus (receptors) located at the endings of the sensory nerves is transmitted along nerve trunks to the central nervous system (the spinal cord and the brain). Upon reaching the cerebral cortex the stimulation is transformed into a pain sensation. Anesthesia can therefore be produced either by the action of anesthetics on the peripheral endings of sensory nerves (receptors) or by influence on the central nervous system (cerebral cortex). When influence is exerted on the peripheral endings of sensory nerves, the patients retain complete consciousness, but do not feel pain because the receptors cannot be stimulated. This method of anesthesia is called local anesthesia. When the central nervous system (the cerebral cortex and subcortical centres) are acted upon, man loses consciousness, lapses into deep sleep and does not feel any pain at all. This form of anesthesia is known as general anesthesia.

The method of anesthesia to be chosen in each particular case depends on a number of conditions. The mental state of the patient is also of some importance. If the patient is very anxious, is afraid of the operation and cannot endure the slightest pain, for example, the pain produced by a puncture, he cannot tolerate local anesthesia and must be given general anesthesia.

In addition to the state of the patient's higher nervous activity and his own attitude to the induction of sleep or local anesthesia, the following factors are taken into account during the choice of anesthesia—condition of internal organs (heart, liver, kidneys), character and duration of the operation, region of surgical intervention, presence of experienced anesthetists and equipment.

It should be noted that anesthesia itself, especially general anesthesia, holds out some danger for the patient's life. This danger has been considerably reduced by modern anesthesia in which the anesthetist not only aims at desensitising the patient

but, by bringing certain influences to bear on the physiological functions of the organism, also helps to compensate for all the disturbances in the general condition of the patient during the operation.

In addition to general anesthetics (ether, nitrous oxide) and local anesthetics (novocain) modern anesthesiology makes use of hypnotics, neuroplegic and ganglion-blocking substances, and especially muscle relaxants. Anesthesiologists now make use of artificial sleep, controlled hypotension (lowered blood pressure), and physical and chemical hypothermia (lowered temperature of the patient's body)—moderate (30-28°C) and profound (10-8°C).

Potentiated anesthesia, i.e., anesthesia produced by a combination of different anesthetics, which intensify the effect of each other, is one of the modern methods of anesthesia.

This requires well trained anesthetists and competent assistants. In addition to well trained anesthetists, the extensive development of modern forms of anesthesia requires special apparatus and a good supply of drugs.

Simultaneously with choosing the form of anesthesia certain preparatory measures are taken on the basis of the data obtained by examination of the patient.

GENERAL ANESTHESIA

The anesthetic is introduced into the patient's organism as follows: 1) with the inhaled air into the lungs where it is absorbed by the blood—*inhalation anesthesia*, and 2) through the rectum into the intestines where it is also absorbed by the blood, and directly into the blood (into a vein). The last two forms are called *noninhalation anesthesia*. In all these cases the anesthetic finally gets into the blood and is brought by the blood to the central nervous system (cerebral cortex and the brain stem reticular formation), where it is retained and where it produces its effect.

INHALATION ANESTHESIA

The most widespread method of general anesthesia is *inhalation anesthesia*. For this form of anesthesia ether and nitrous oxide are mainly used. Ether (Aether pro narcosi) is a transparent readily inflammable liquid with a characteristic odour. In the light ether disintegrates and is therefore kept in dark bottles and in a dark place.

Ether kept in open vessels should not be used for anesthesia because it disintegrates in the air.

General anesthesia affects the entire organism, especially the central nervous system and particularly the *cerebral cortex*, inducing *narcotic sleep* in the patient.

The works of the Soviet physiologists N. Vvedensky and I. Pavlov have shown that anesthesia results from the action of the anesthetic on the central nervous system, primarily the cerebral cortex, which inhibits the reflex activity, first of the cerebral cortex and then of the subcortex.

During anesthesia the patient's life is in the hands of the anesthetist and the slightest neglect on the part of the latter may cost the patient his life.

Preparation for General Anesthesia, or Premedication. Production of anesthesia is considerably facilitated by pharmacological preparation (premedication) of the patient.

For the night preceding the operation the patient is given a hypnotic (luminal, barbamyl). About 20-30 minutes before producing general anesthesia the patient is subcutaneously administered morphine or promedole (4-phenyl-4-propoxy-1,2, 5-trimethyl-piperidine hydrochloride) and atropine or scopolamine to reduce secretion of mucus.

Course of inhalation anesthesia. The *first stage*, the stage of analgesia, is characterised by a progressive loss of sensation, altered consciousness and retention of the reflexes. The patient loses count, his pulse and respiratory rates increase, and the skin usually becomes flushed. Minor operations can be performed during this stage. The patient recovers consciousness soon after administration of the anesthetic ceases.

During this stage it is necessary to watch the patient, his pulse, respiration and pupils, and to note all changes that take place because dangerous complications requiring suspension of anesthesia may develop already at this stage (see *Complications of Anesthesia*).

Second stage of anesthesia—period of excitement. In debilitated children and women this stage is scarcely noticeable; it is more pronounced in men, especially dipsomaniacs. The better the premedication, the less pronounced the excitement. During this stage the patient develops convulsive movements, screams, and tries to throw off the mask; sometimes he jumps off the table, if he is poorly fastened or not restrained, in which case he is likely to get hurt and to hurt those around him. This stage is not fit for operating. Production of anesthesia must be continued until the onset of the *third* or *surgical stage*. This stage is divided into four planes depending on the depth of the anesthesia.

The first plane is a mild form of general anesthesia; it is marked by a narrowing of the pupils, retained reaction to light and eyeball movement, loss of consciousness, as well as pain and tactile sensation. The corneal and pharyngeal reflexes are retained,

the arterial pressure, pulse and respiration are the same as before anesthesia.

Second plane: a deepening of anesthesia leads to disappearance of the corneal reflex and cessation of eyeball movement; the pupils are constricted and react to light sluggishly, respiration is slow, the pulse and arterial pressure are unaffected.

The two foregoing planes characterise superficial anesthesia.

Continued deepening of anesthesia leads to the third plane which is characterised by a slight dilatation of the pupils and loss of its reaction to light, weakening of costal respiration, drop in arterial pressure and pallor of the skin.

The fourth plane is marked by greater dilatation of the pupils, shallow diaphragmatic respiration with short inhalations and long exhalations, and rapid pulse. This plane is observed only as a result of overdosing the anesthetic.

Cessation of administration of the anesthetic is followed by the *period of awakening* which lasts from the moment the mask is removed and the patient begins to breathe pure air until complete return of consciousness. The duration of this period varies and depends on the anesthetic used, the duration of anesthesia. depth of sleep and individuality of the patient. Disinhibition occurs in the reverse order. The period of awakening may be accompanied by great excitement of the patient, which sometimes goes as far as violence, and is accompanied by tears or laughter. At this time the patient must be carefully watched so that he may not get off the bed, tear off the dressings, etc. If the patient falls asleep again, he must not be awakened.

Peculiarities of ether anesthesia. The unpleasant aspect of ether anesthesia is a long and distressing period of excitement and abundant salivation. The patient's pharynx has to be dried with gauze. Owing to the intense cooling of the lungs, penetration of saliva into the lungs and the effect of ether on pulmonary tissue, subsequent pulmonary complications are observed when this form of anesthesia is produced. But the first and main complication in ether anesthesia is asphyxia (see below). During ether anesthesia cardiac arrest is usually preceded by asphyxia which is less dangerous than sudden cardiac arrest and is more easily eliminated.

METHODS OF INHALATION ANESTHESIA

Open method. With the use of a mask (Fig. 88), a wire frame covered with gauze, to which the anesthetic is applied in drops, the anesthetic enters the respiratory tract together with the air and is excreted during exhalation.

Techniques of administering inhalation anesthesia. For anesthesia it is necessary to prepare on a separate table the mask, drop-

pers with ether, mouth dilator, tongue holder, tampon holder, blindfold, vaseline, towel and pan in case the patient should vomit. Moreover, considering the possibility of complications, it is necessary to have nearby a syringe and needles; a solution of camphor and caffeine, and cylinders with oxygen and carbon dioxide.

On the anesthetic table there should be ready for injection a 5 per cent ephedrine solution to be administered subcutaneously in case of circulatory disturbances, especially during falls in blood pressure, in a dose of 1 ml of the solution and 1 ml of cordiamine.

The patient prepared for the operation is placed on the table, his legs are tied above the knee joints, the nose, cheeks and chin are painted with vaseline to prevent burns, should any ether get on the skin of the face. To protect the patient's eyes from burns, they are covered with a towel. Artificial teeth (removable prostheses) should be taken out. The latter is done to prevent the patient from swallowing them during sleep.

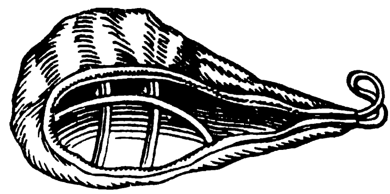


Fig. 88. Mask

Following this a mask (Fig. 88) is placed on the patient's face. To prevent unpleasant sensations of choking in the beginning of anesthesia, the patient should at first be given a chance to get used to the smell of ether by several inhalations and then the mask should finally be adjusted.

To administer anesthetics into the lungs, more complex apparatus in which the air or oxygen are mixed with vapours of ether, fluotane, cyclopropane or nitrous oxide may be used.

Closed systems of apparatus (for closed circuit anesthesia) are used; in these systems the carbon dioxide exhaled by the patient is absorbed by special absorbing devices, while the anesthetic with oxygen added re-enters the patient's lungs. In a semi-closed system, owing to a valve device, the air from the lungs is exhaled together with the anesthetic to the exterior, and new portions of the anesthetic are inhaled together with oxygen. The concentration of ether vapours in the blood during deep stages of anesthesia amounts to 5 per cent by volume.

The course of anesthesia is considerably improved by good premedication (see page 76).

During production of anesthesia it is necessary to watch the position of the patient's arm which is not tied and by which the pulse and blood pressure are observed; it must not be placed on the edge of the table or sharply thrown up because in the former case the radial nerve compressed on the back of the arm may become paralysed, and in the latter case the whole brachial

nervous plexus is compressed between the clavicle and first rib, which also leads to paralysis. The pulse may be observed by placing a finger on the carotid artery on the neck under the angle of the jaw; in that case both of the patient's arms may be tied along the body or one arm may be tied in an abducted position to a special arm support for observing the blood pressure and for intravenous injections.

Ether analgesia. As we have already mentioned, pain sensitivity ceases during the first stage of anesthesia, and this period can be utilised for small operations, for example, incisions. It begins as usual, but ceases during the first stage. This form of anesthesia may also be administered differently. About 30.0 of ether is poured at one time into a large mask, the mask is put on the patient's face and the patient is asked to make several deep inhalations. Usually the patient loses sensitivity about 2-3 minutes after making several inhalations. The patient is asked several questions or is requested to count in the very beginning of anesthesia, and the moment at which he ceases to answer questions or loses count indicates suspension of pain sensitivity. The intoxication ends soon after removal of the mask. This makes it possible to use this kind of analgesia in dispensary practice. By mastering the techniques of this form of analgesia it is possible to prolong the loss of sensitivity to 10-15 minutes.

Ethyl chloride (chlorethyl) anesthesia. Ethyl chloride anesthesia is used for short operations. A fine stream of ethyl chloride is sprayed from an ampule on to a gauze towel or mask from a height of about 50 cm. After a few inhalations the patient becomes insensitive to pain. Such anesthesia develops rapidly and does not produce the usual excitement; consciousness returns soon after cessation of its administration. By deepening this form of anesthesia it is possible to produce complete ethyl chloride anesthesia. This anesthesia is very valuable for operations lasting but several minutes. Usually long operations are not performed under ethyl chloride anesthesia and require administration of ether.

The *semi-closed and closed methods* require special apparatus. With the semi-closed method the anesthetic vapours or gas enter the patient's lungs together with oxygen from the cylinders and are exhaled into the air.

With the closed method the anesthetic enters the patient's respiratory tract together with the oxygen and during exhalation gets into the same closed system where the carbon dioxide exhaled by the patient is taken up by an absorber containing natron lime, while the anesthetic mixes with oxygen and re-enters the lungs.

Ether-oxygen anesthesia. For anesthesia with a mixture of ether and oxygen, as well as for gaseous anesthesia (see below) special equipment is used.

The main parts of the equipment (Soviet apparatus AN-1 shown in Fig. 89) are:

1. A truck on which the cylinders with gas (oxygen, carbon dioxide, nitrous oxide and cyclopropane) and the other parts of the apparatus are fastened.

2. Each cylinder has a reducing gear with pressure gauges

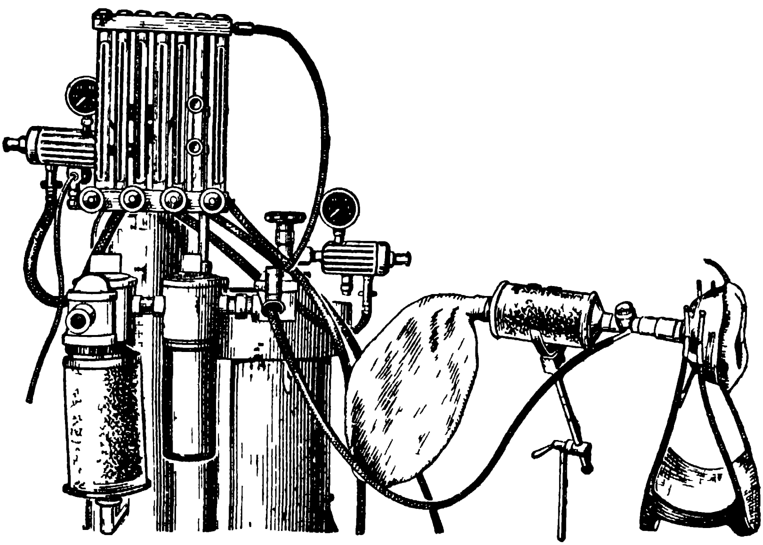


Fig. 89. Apparatus AN-1

(Fig. 90) to reduce the pressure of gas in the cylinder and make it safe for the patient. One pressure gauge (*a*) shows the pressure of gas in the cylinder, the other pressure gauge shows the pressure of the gas entering the apparatus (*b*) and, consequently, the patient's lungs. The feed of gas is controlled by a locking valve (*c*).

3. The feed of gas (oxygen, nitrous oxide) is recorded by dosimeters (feed of gas in litres per minute) and is regulated by handles of the gas regulator).

4. The gas circulation governor has a carbon dioxide absorber (Fig. 91). Owing to this system the carbon dioxide and vapours of the air exhaled by the patient are absorbed by the natron lime and the anesthetic is not voided from the system to the exterior but re-enters the patient's lungs.

5. For ether-oxygen anesthesia there is a glass ether jar (Fig. 92) with an evaporator; the oxygen passing through this jar is enriched with ether vapours. The amount of ether being fed is regu-

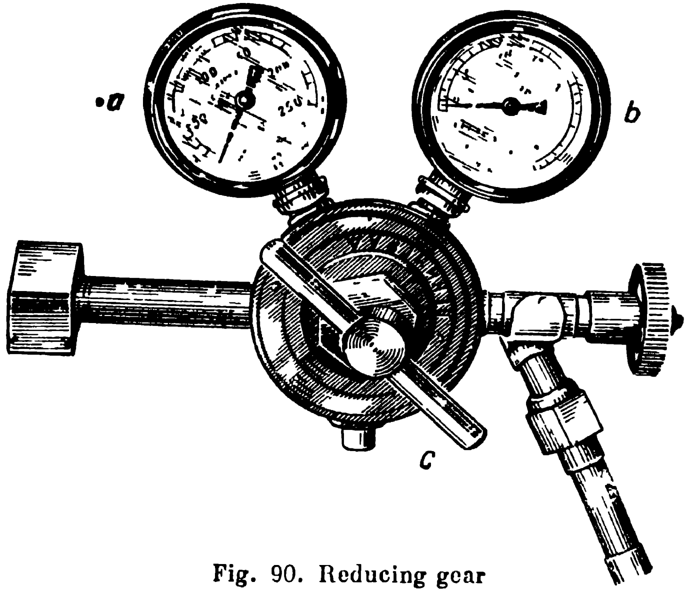


Fig. 90. Reducing gear

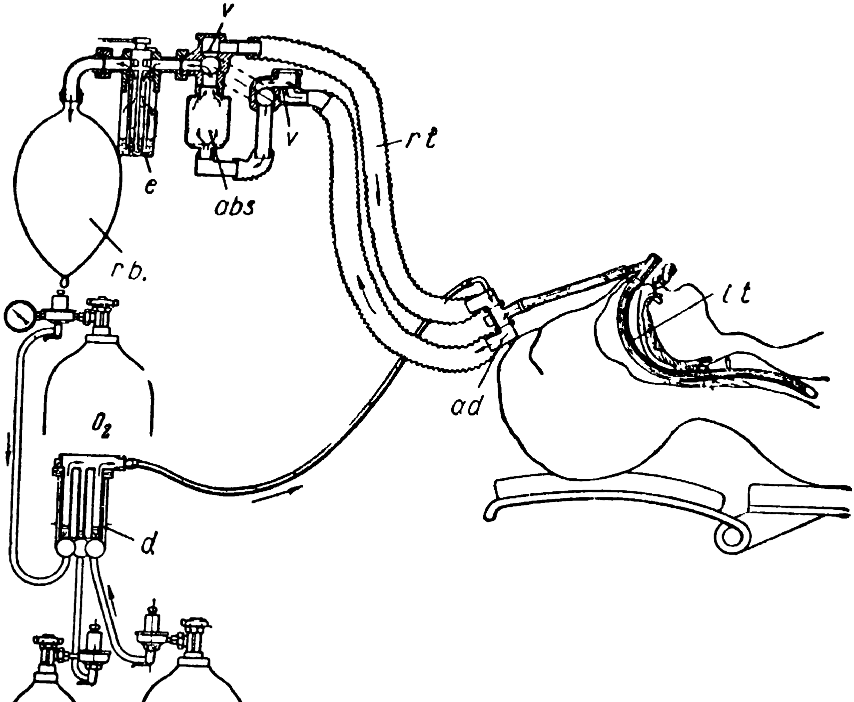


Fig. 91 Closed method of intubation anesthesia. Circulation system
d—dosimeter, *r b* —respiratory bag, *e*—ether evaporator; *abs*— absorber, *v*—circulation valves, *r t* —respiratory tubes, *ad*—adapter, *t t* — intubation tube

lated by the handle of the governor set in the position of the pointer from 0 (no ether is fed) to 8 (maximum feed of ether).

6. In addition, the apparatus has connecting rubber tubes for conducting the gases from the reducing gear of the cylinder to the dosimeters, a respiratory rubber bag, a crimped respiratory tube with a connecting tee for joining it to the mask or intubation tube.

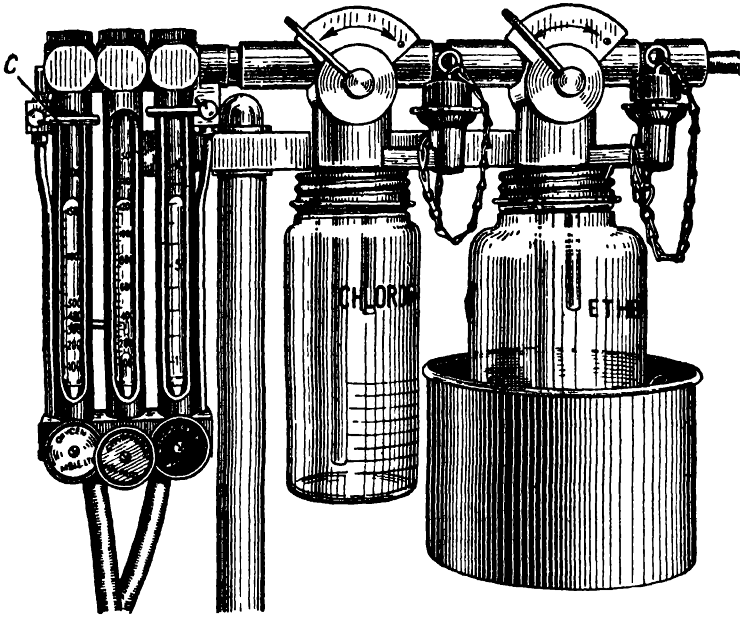


Fig. 92. System of dosimeters and evaporators C – emergency oxygen feed cock

Preparation of the apparatus for anesthesia consists in checking on the pressure of the gases and oxygen by the indications of the pressure gauges. The natron lime is replaced after each operation, or the time the natron lime was used is checked by the time indicator on the lid of the circulation governor during repeated anesthesias. The adsorber is designed for six hours of work.

A mask of requisite size is chosen and connected with the respiratory tube of the apparatus. In ether-oxygen anesthesia 100.0 of ether is introduced into the aforementioned glass ether jar. The access of oxygen into the apparatus is opened by pressing the button of the extra gas feed, the oxygen filling the rubber bag and tubes. A turn of the governor's handle establishes a con-

stant feed of oxygen to the mask. After the mask has been placed on the region of the mouth and nose it is fastened with rubber straps (Fig. 93) so that it fits tightly and the air does not by-pass the mask during respiration. As soon as the patient gets used to breathing oxygen through the mask, ether begins to be gradually added by turning the handle on the ether jar one or two points in the position of the pointer. When the patient gets used to the smell of ether, the handle is slowly moved 1-2 points and the effect of the anesthesia on the patient is observed. With the onset of the third stage of anesthesia the feed of ether is reduced by setting the handle of the ether jar on points two or three.


Fig. 93. Fixation of mask

In gaseous anesthesia, for example nitrous oxide, the apparatus is examined, filled with oxygen and, after the mask is fastened, the handle of the dosimeter governor is set and gas begins to be fed in amounts not exceeding 80 per cent bitrous oxide and 20 per cent oxygen.

Service and maintenance of the apparatus. The apparatus may be used only when it is in complete order. The reducing gears may be repaired only by specialists. When assembled, the parts of the reducing gear must have no traces of oils or grease. The valves of the cylinders must not be opened fast. After the requisite pressure has been set, the locking valve of the reducing gear has to be closed. It should be remembered that in the cylinders the gas is under high pressure and unskilful manipulations of the reducing gears are dangerous.

After anesthesia all the valves on the cylinders have to be closed, the mask and crimped tubes with the tee must be washed in warm water, stretched vertically, shaken off and dried. The mask must be wiped with alcohol. The ether jar has to be unscrewed and the remnants of ether poured out; the natron lime must be removed from the absorber. The apparatus must be covered with a sheet and kept in a cool place (not in the sun).

Intratracheal (intubation) method of anesthesia. Used for the first time by N. I. Pirogov experimentally, intratracheal administration of an anesthetic by means of special apparatus and tubes is gaining wide currency.

Insertion of a tube through the nose proved inconvenient and the tube is therefore introduced through the mouth under local

anesthesia of the pharynx and larynx or, what is done much more frequently, under general anesthesia.

The patient is placed in a supine position with his head reaching beyond the end of the operating table (Fig. 94). To introduce the tube, special laryngoscopes with distal light for direct laryngoscopy are used. After inserting the laryngoscope in the patient's mouth, the root of the tongue and the epiglottis are pressed back. As soon as the larynx can be seen a tube (its diameter chosen beforehand) is inserted in it between the vocal cords. For an adult the internal diameter should be at least 9 mm. The depth to which the tube is inserted is measured in advance

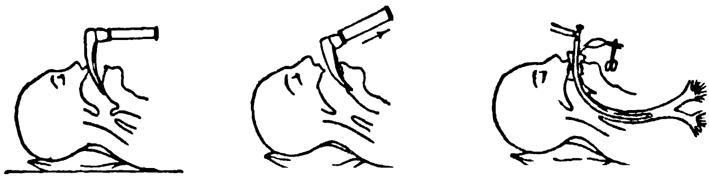


Fig. 94. Inserting the intratracheal tube

by placing the tube on the exterior surface of the face and neck along the course of the oral cavity, pharynx and trachea. The distance must not exceed that from the front teeth to the point of insertion of the second costal cartilage to the sternum. Deeper insertion may exclude one of the lungs from respiration if the tube obturates one of the bronchi.

It is necessary to see to it that there are no bends either in the external or internal parts of the intubation tube.

Biting of the tube is prevented by insertion of special retractors between the teeth. After connecting the intratracheal tube with the sleeve of the apparatus anesthesia is continued by administration of the ether-oxygen mixture.

Contraindications to general anesthesia. The following factors are regarded as contraindications to general anesthesia: severe pulmonary diseases (ether anesthesia is particularly contraindicated), degeneration of the heart muscle, diseases of the blood (for example, severe anemia), diseases of the endocrine glands (adrenals), severe diseases of the kidneys and liver, extreme general emaciation, etc. A careful preliminary examination of the patient and strict individualisation help to foresee the possibility of many complications of anesthesia.

These contraindications pertain to ether anesthesia administered with a usual mask. With modern ether-oxygen and gaseous anesthesia the contraindications have greatly decreased and

anesthesia may now be administered to very grave patients, for example cardiacs.

Complications in anesthesia. Prevention and control of complications. One of the most usual complications in anesthesia is *retraction of the tongue.* During the period of deep sleep the muscles, particularly those of the tongue and floor of the mouth relax, owing to which, with the patient in a supine position, the tongue shifts in the direction of the posterior wall of the pharynx and presses against the epiglottis which may cover the entrance to the larynx. During this complication the patient usually turns blue (cyanosis), the blood becomes darker, the pulse beats more rapidly and the respiratory movements grow more intense.

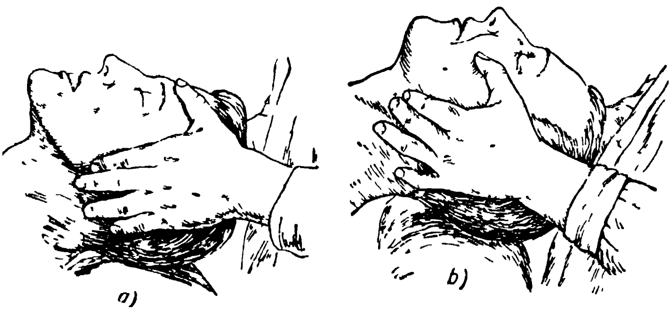


Fig. 95. Holding the jaw
a—right way, *b*—wrong way

To prevent retraction of the tongue, the anesthetist's assistant must hold the patient's lower jaw protruding forward (Fig. 95, *a*).

Respiratory difficulties are possible in cases of apparatus anesthesia produced through a mask. Compression of the jaws and lips gives rise to snoring which denotes a slight respiratory difficulty. To prevent graver respiratory disturbances in such cases, a tube 8-9 mm in diameter and 12-14 cm long is introduced through the nose (nasal airway). The tube is prevented from entering the trachea by puncturing the external end with a safety pin. The external ends of special tubes are expanded.

Introduction of flat tubes or a wire carcass shaped to fit the hard palate (oral airway) serves the same purpose of preventing respiratory difficulties. If the snoring continues, the position of the patient's head is changed until the patient begins to breathe noiselessly. If the patient starts coughing or making swallowing movements, the anesthesia has to be deepened.

Appearance of cyanosis indicates that the intubation tube is maladjusted or was improperly chosen.

Vomiting is not an infrequent complication in anesthesia. It occurs when anesthesia is shallow and the patient awakens, for

which reason anesthesia must be deepened upon appearance of vomiting. Vomiting is dangerous in that the vomit may gain entrance into the patient's trachea and cause asphyxia, or the patient may vomit on the operating table. In the latter case the rules of asepsis are violated. To avoid this, the patient's head is turned to the side opposite the operative field and his mouth is opened so that the vomit may readily come to the exterior. Vomiting is particularly unpleasant during operations on the face and abdominal cavity, especially the intestines.

Asphyxia. A graver complication during anesthesia is *respiratory arrest* (asphyxia) caused by the action of the anesthetic on the respiratory centres in the medulla oblongata or by vomit, blood, saliva, etc., penetrating into the trachea. In the latter case the pharynx must be quickly cleaned. If it is difficult to open the mouth, the mouth dilator should be used, as indicated above.

Respiratory arrest is attended with an appearance of a bluish coloration of the skin and mucosa, dilation of the pupils and darkening of the blood. This is followed by a weakening and then cessation of cardiac activity. It should be remembered that after the end of the operation and removal of the mask the patient should under no circumstances be placed in a sitting position or generally considerably and abruptly lifted because this is likely to produce paralysis of the respiratory centre in the medulla oblongata.

Primary respiratory arrest from anesthesia is most frequently observed in alcoholics in whom the period of excitement was very long and severe. Upon the onset of asphyxia anesthesia should be immediately discontinued and the mask removed from the patient's face. The only correct way to prevent asphyxia is carefully to watch the patient during anesthesia and correspondingly to reduce the anesthetic at the first signs of possible complications.

During the initial signs of asphyxia caused by intoxication with the anesthetic, when the patient still breathes but his breathing is shallow, inhalation of carbon dioxide produces good results. For this purpose a catheter connected with the cylinder filled with carbon dioxide is inserted in a nostril. After several inhalations respiration usually becomes deeper. If the patient has developed cyanosis and does not get enough oxygen, it is desirable to let the patient breathe oxygen during the operation.

In cases of complete respiratory arrest no time should be wasted on other measures, and artificial respiration—the most appropriate and only life-saving measure—should be immediately resorted to. Before administering artificial respiration it is necessary to give the air ready access into the patient's respiratory tract, which is attained by inserting a mouth dilator

and drawing out of the tongue; it is also necessary to ensure an influx of fresh air into the room.

One of the widespread methods of artificial respiration is the Silvester method. The person administering artificial respiration stands at the head of the patient, grasps both his forearms

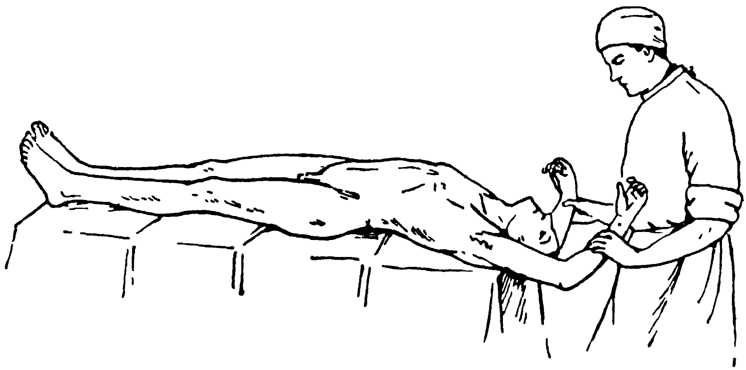


Fig. 96. Silvester's method of artificial respiration (inhalation)

and stretches them beyond the patient's head, i.e., he raises them and simultaneously draws them back in the direction of the patient's back (Fig. 96). This causes an inhalation. A quick

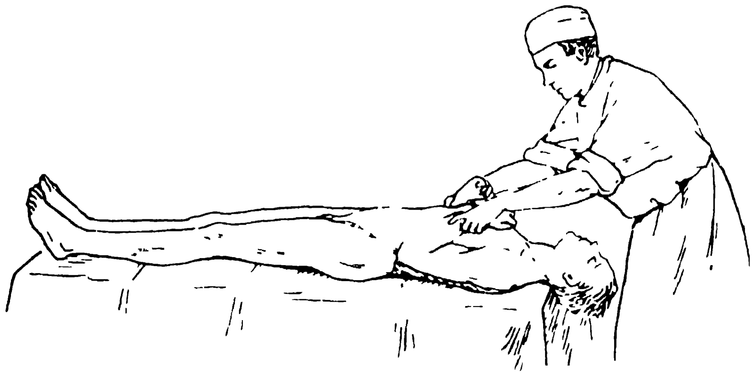


Fig. 97. Silvester's method of artificial respiration (exhalation)

lowering of the arms and compression of the lower part of the thorax with them produce an exhalation (Fig. 97). While doing this, the anesthetist or his assistant, using the patient's forearms as levers, strongly presses the elbows and upper arms to the lower part of the thorax and compresses it. Each of these movements is repeated rhythmically 16-20 times per minute. It should

be remembered that a faster rhythm does not help, but is, on the contrary, harmful. The following mistake is also not infrequently observed: the tongue is pulled during exhalation and dropped during inhalation, thus shutting the entrance into the larynx.

If artificial respiration fails to produce immediate results, it must be continued for several hours, because there were cases in which respiration was restored even after so long a period.

A very good method in the very beginning of asphyxia is stimulation of the posterior wall of the pharynx by pressing the root of the tongue against it rhythmically with the aid of a tongue-holder. To do this, the patient's mouth has to be opened, the tongue must be grasped with a tongue-holder, pulled out and then tightly pressed against the pharynx rhythmically 16-20 times per minute (respiratory rate); after several such movements the patient usually begins to breathe naturally.

In cases of ether-oxygen intubation anesthesia artificial respiration is administered by rhythmic compression of the respiratory bag, thus introducing oxygen into the patient's lungs. Various apparatus for administering artificial respiration or special devices for inhalation anesthesia apparatus are also used; these apparatus produce respiration under positive and negative pressure.

Cardiac arrest. The gravest complication of anesthesia is cardiac arrest which develops either after a progressive decline of cardiac activity or without any prelude. The pulse quickens and weakens, the blood pressure drops, the patient becomes pale, his pupils sharply dilate and do not react to light, and his muscles relax.

Cardiac arrest may be of a reflex nature or may be caused by an overdose of the anesthetic, especially in cases of considerable myocardial changes.

On weakening of cardiac activity and drop in blood pressure administration of the anesthetic is suspended, the patient is given cardiacs (cardiazol, caffeine, strophanthin), administered artificial respiration, and given transfusions of blood or blood substitutes.

In cases of cardiac arrest the production of anesthesia is discontinued, the patient is given cardiac massage, artificial respiration is induced, an intracardiac injection of adrenalin (1 ml of 1 : 1000) is made, an intraarterial blood infusion is administered and the normal sinus rhythm is restored by means of a defibrillator.

Death resulting from general anesthesia. Death from general anesthesia may occur during any of its stages, but most frequently during the period of deep sleep, as a result of the aforementioned

complications. Careful and skilful management of anesthesia eliminates in most cases the danger of death, but in a certain insignificant number of cases death is due to a special sensitivity of the patient to general anesthesia.

Postoperative complications. During the postoperative period the patient is subject to a number of complications which are directly dependent on anesthesia. During the first hours after anesthesia, when the patient is still asleep, he is in danger of asphyxia caused by retraction of the tongue. Careful watching, proper setting of the lower jaw and, in extreme cases, pulling out the tongue easily prevent this complication. Another most frequent complication of anesthesia is vomiting. Usually it occurs on the first day and ceases the following morning. To prevent vomiting, the patient is put to bed without a pillow under his head, during dressing his head is not raised and is turned carefully. If possible, the patient is placed on his right side and is not spoken to; the room is thoroughly aired. Long abstinence from drinking is no longer practised; on the contrary, if vomiting does not cease within 6-7 hours, the patient is given a warm drink (if the operation does not contraindicate it). The consumed liquid is frequently ejected with vomit, following which vomiting ceases. To prevent the vomit from entering the trachea, the patient's head is turned to the side.

During the first hours after the operation the patient is not infrequently uneasy. He may jump up, tear off the dressing and hurt himself. During this time the patient must be restrained; it is best to tie him to the bed beforehand. For this purpose a pillow is placed on his thighs and knees and the patient is tied to his bed with a wide towel or sheet over the pillow. The patient must be restrained carefully, so that he is not hurt.

Late complications. Certain complications sometimes occur several days after anesthesia, but they are also due to anesthesia. These complications include degeneration of the liver, heart and kidneys, and particularly complications in the lungs (bronchitis and pneumonia). The latter are caused by penetration of saliva and sometimes vomit into the lungs during anesthesia, extreme cooling of the lungs, effect of the anesthetic on pulmonary tissue, poor pulmonary ventilation during the postoperative period, etc. The patients with these complications often require prolonged treatment, while weak patients are sometimes in danger of dying. Mention should also be made of paralyses of nerves resulting from their compression during the operation, for example, when the hands are thrown back of the head during the operation. These paralyses require long treatment and the responsibility for them is borne wholly by the anesthetist.

Intravenous Anesthesia. The substances used for intravenous anesthesia today are various derivatives of barbituric acid: hexobarbitone and a 2 per cent pentothal sodium solution. Hexobarbitone is put out in ampules containing 1.0 of its powder. The ampules are opened directly before using, 25 ml of distilled water is introduced into each ampule and the solution is drawn into a syringe. The preparation must be injected into the vein slowly. Narcotic sleep is induced instantaneously, without the excitement stage. Hexobarbitone anesthesia is contraindicated in cases of liver affection, extreme emaciation and severe internal diseases. Hexobarbitone anesthesia is very dangerous when administered unskilfully, very rapidly and in an overdose.

This anesthesia is usually followed by several hours of sleep. During this time the patient must be closely watched because, as long as he is in a state of narcotic sleep, he may develop the usual anesthetic complications (asphyxia, cardiac weakness). After the end of anesthesia great excitement is sometimes observed and the patient must be restrained.

Rectal Anesthesia. For some operations on the head and neck in children and in the mouth and pharynx in adults it is very inconvenient to administer the anesthetic through the respiratory tract. In such cases the anesthetics are given through the rectum.

For rectal anesthesia avertin (narcolan) is used. It is administered in the form of a freshly prepared 2.5-3 per cent solution in a dose of 0.1-0.2 per one kilogram of the patient's weight. First, the solution is heated to 45°C and towards the moment of administration is cooled to 39°C. Anesthesia develops within 12-15 minutes. Before administration of avertin or in the morning of the operation day the patient is given a cleansing enema, and after the end of the operation his intestines are washed out with a syphon enema.

Hexobarbitone may also be used for rectal anesthesia in the same dose as it is administered intramuscularly.

ANESTHETIST'S MISTAKES

The following flagrant mistakes are due to neglect: removable prostheses left in the mouth, pulse and respiratory arrest observed too late, and vomiting because of an unpurged stomach during an urgent operation. The mistakes due to inexperience include attempts to raise the patient's jaw and pull out the tongue with the teeth clenched, and discontinuance of anesthesia during vomiting. In the foregoing cases anesthesia should be deepened. Also because of inexperience the anesthetist not

infrequently mistakes interrupted respiration during incomplete anesthesia for its arrest caused by an overdose, and, on the contrary, an overdose and asphyxia—for interrupted respiration.

PRINCIPLES OF MODERN ANESTHESIOLOGY

The open (drop) method of ether anesthesia produced through a mask is still used wherever there are no anesthesiologists and modern apparatus. In this form of anesthesia the muscles relax only during deep stages of anesthesia with highly toxic concentrations of the anesthetics.

Induction anesthesia. To produce the highest concentration of the anesthetic in the beginning of anesthesia, special induction forms of anesthesia are sometimes resorted to, i. e., a short-action barbiturate (pentothal sodium) or a quick-action gas anesthetic (cyclopropane, nitrous oxide) is administered.

Basal anesthesia. It is also possible to produce prolonged mild anesthesia, for example, rectal anesthesia, which serves as a basis for general inhalation anesthesia.

Potentiated anesthesia. In modern anesthesiology a combination of different forms of general and local anesthesia, i. e., combined anesthesia, is increasingly gaining ground. With summation of the effects of different anesthetics a lesser amount of each of them is required and the negative aspects of their action, particularly their toxicity, are in a certain measure eliminated. With a correct choice of the anesthetics the effect of one substance may be enhanced by that of another. This form of anesthesia is known as potentiated anesthesia.

Ganglion-blocking substances. Methonium salts are administered subcutaneously or intramuscularly in a dose of 1 ml of a 2 per cent solution. They weaken the conduction of nervous impulses to the organs and depress the blood pressure, i. e., produce hypotension (a drop to 80-70 mm is permissible), thus lessening bleeding. Pentamine is administered intramuscularly in a dose of 0.4 to 1-2 ml of a 5 per cent solution; its action is similar to that of hexamethonium.

Neuroplegic substances, such as aminazine (chlorpromazine) (0.025 per os or 5 ml of a 0.5 per cent solution intramuscularly), act on certain parts of the central nervous system and on the endocrine system; they also act as antipyretics. Their administration facilitates production of anesthesia, reduces the amount of the main anesthetic needed for anesthesia and prevents disturbances in the activity of the cardiovascular system.

Muscle relaxants or curarimimetic substances, such as ditiline, in doses of 2-3 ml of a 2 per cent solution administered intravenously (short-action), and diplacin in doses of 5-7.5 ml of a 2 per cent solution administered intravenously (longer-action)

produce muscular relaxation, thus facilitating surgical operation, especially in the abdominal cavity. Owing to their administration no deep sleep with muscular relaxation has to be induced.

The overwhelming majority of operations may be performed under anesthesia, in the stage of analgesia on the first plane of the third stage without muscular relaxation, which considerably reduces the total amount of the main anesthetic needed for the operation and eliminates the dangerous concentrations of the anesthetic required for relaxing the muscles.

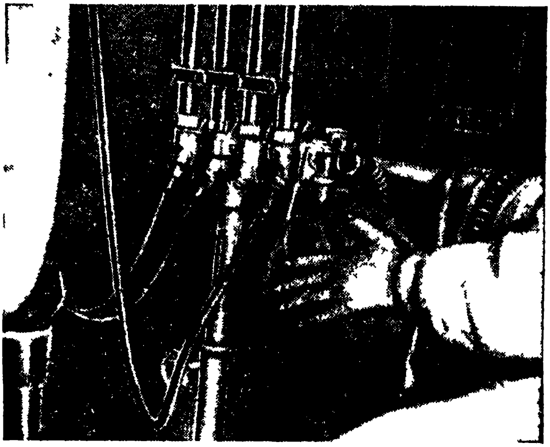


Fig. 98. Controlled respiration

Since relaxants exclude natural respiration and artificial respiration has to be resorted to for some time, they are administered almost exclusively in combination with intratracheal anesthesia before or directly after intubation.

Administration of relaxants and exclusion of natural respiration make it possible to administer controlled respiration (Fig. 98), i. e., artificial respiration by rhythmically compressing the bag of the anesthetic apparatus with rhythmic feeding of oxygen to the lungs, or by using special rhythmically moving bellows which alternate the inhalations and exhalations during artificial respiration.

To exclude natural respiration completely and pass to controlled (artificial) respiration, 2-3 ml of a 2 per cent diplacin solution is administered intravenously, the administration being repeated upon cessation of its effect (1.5-2 mg per 1 kg of the patient's weight).

Potentiated local anesthesia implies local anesthesia produced by administration of procaine solution in combination with ganglion-blocking and neuroplegic substances (2 per cent solution of aminazine)—2 ml administered intramuscularly in combina-

tion with dimedrol ([diphenydramine] 2 per cent solution—2 ml intramuscularly), promedole (4-phenyl-4-propoxy-1,2,5-trimethyl-piperidine hydrochloride, 2 per cent solution—2 ml intramuscularly) and pantopon or scopolamine (0.05 per cent solution—1ml intramuscularly ["cocktail litique"]).

Administration of the foregoing substances induces a drowsy or sleepy state.

Induction of general anesthesia with hexobarbitone sodium or pentothal and administration of the basic intratracheal ether-oxygen or nitrous oxide-oxygen anesthesia in combination with relaxants and small amounts of neuroplegic substances makes it possible to perform the gravest, most difficult and protracted operations without cardiovascular disturbances. It also improves the postoperative period, and the results of the surgical treatment in general.

Administration of anesthetics, ganglion-blocking and neuroplegic substances and relaxants imperils the life of the patient. Modern potentiated anesthesia may therefore be administered only by specially trained teams consisting of an anesthetist and trained nurses.

Hypothermia. Hypothermia is artificial cooling of the body with simultaneous inhibition of thermoregulation by anesthetics and neuroplegics. It diminishes metabolism, decreases the need of the tissues in oxygen, enhances the resistance of the organism to oxygen starvation and prolongs the period of exsanguination of the brain permissible during operation from 3-5 to 15-20 minutes. This circumstance makes it possible to exclude the heart from the circulation and to perform operations on an open "dry" heart. During hypothermia the blood pressure drops and cardiac activity slows down. The temperature of the body is reduced by physical methods (cooling in a bathtub, use of special clothing in which cool water is circulated, application of ice bags to the patient, cooling of the injected blood, cooling of the brain, etc.). The temperature of the blood is reduced to 30-28°C. Greater reduction may produce undesirable complications. Hypothermia is indicated for intracardiac operations in inborn heart defects accompanied by oxygen starvation, in circulatory insufficiency in weakened patients and in certain neurosurgical diseases. It is usually produced during intratracheal anesthesia after the onset of deep sleep.

Hypothermia produces the following complications: cardiac fibrillation during the postoperative period, fever up to 40°C and hemorrhages.

SPINAL ANESTHESIA

Production of spinal anesthesia requires a hollow needle 8-10 cm long with a mandrin inserted into its lumen, a 5-10-cm syringe, forceps for grasping the gauze or cotton, while disinfect-

ing the skin, and collodion. A 5 per cent novocain solution and a 1 per cent sovcaine (nupercaine) solution are most frequently used as anesthetics.

This anesthesia is produced as follows: the patient is seated on a table so that his legs rest on a stool placed next to the table and his elbows—on his knees. He is asked to curve his back as shown in Fig. 99. The skin of the back along the line of the vertebral processes is disinfected with alcohol. The space between the fourth and fifth lumbar vertebrae is found and the needle is inserted in it to a depth of 6-8 cm. After this the mandrin is removed. If the needle has penetrated into the spinal canal, the cerebrospinal fluid begins to flow out in drops. If no cerebrospinal fluid flows out or blood appears instead, it means that the tip of the needle has not penetrated into the spinal canal or has injured a blood vessel. The needle must be removed and an attempt made to reintroduce it. After several drops of the cerebrospinal fluid have flown out, the syringe filled with 2 ml of a 5 per cent novocain solution or 0.5 ml of a 1 per cent sovcaine solution is attached to the needle. The syringe slowly aspirates 1-2 ml of the cerebrospinal fluid and mixes it with the anesthetic solution. Then the mixture is slowly administered into the spinal canal, the needle is removed and the place of the puncture is pasted with collodion. The patient is placed in a supine position. Within 5-10 minutes the patient loses sensitivity of the part of the body below the injection. If the patient is in a position with raised pelvis and lowered head, anesthesia also spreads above the level of the injection. Today spinal anesthesia is used along the entire spine, which makes it possible to perform operations on the trunk. Spinal anesthesia in the region of the thorax, so-called high anesthesia, is dangerous.

Fig. 99. Patient's position for spinal anesthesia

While spinal anesthesia has certain advantages, it also has its shortcomings. It cannot be considered safe because the anesthetic administered into the spinal canal may, by reaching the medulla oblongata, produce paralysis of the vitally important nerve centres of respiration and blood circulation. This is usually preceded by extreme pallor, nausea, vomiting, fall of the blood pressure and respiratory arrest. Particularly frequent are the complications in high spinal anesthesia in the thoracic part

of the spinal canal produced for operations in the upper part of the abdominal cavity. After spinal anesthesia the patient's head is therefore immediately placed on a bolster with the neck bent so that the chin touches the chest. Forming an angle between the axis of the body and the head this position of the patient prevents the anesthetic solution from spreading upward along the spinal canal and, consequently, from acting on the medulla oblongata. Moreover, during spinal anesthesia the patients are under no circumstances allowed abruptly to change their position, especially to assume a sitting or even half-sitting position. It should also be remembered that, when complications occur, raising the head does not eliminate but, on the contrary, increases the symptoms. The best method, if a complication has developed, is complete rest and repeated subcutaneous administration of caffeine, ephedrine or lobeline. Caffeine administered before the operation is useful as a prophylaxis, whereas morphine, on the contrary, should not be administered before the operation. After spinal anesthesia patients not infrequently have headaches and vomit. Under sovcaine anesthesia cyanosis and respiratory disturbances are observed and 1 ml of a 5 per cent ephedrine solution should be administered 10-15 minutes before the beginning of this form of anesthesia. Spinal anesthesia by sovcaine, which lowers the blood pressure, is contraindicated for operations necessitated by trauma and internal hemorrhages.

LOCAL ANESTHESIA

Infiltration and regional anesthesia are distinguished. In the former all the tissues and organs at the site of operation are infiltrated by the anesthetic solution. Certain chemical substances, for example novocain (procaine) solutions, are used as anesthetics. These substances paralyse the nerve endings in the tissues and organs at the site of injection and render this part of the body insensitive to the subsequent surgical intervention. The solutions are injected with a syringe, and usually only the first injection is painful. The skin along the line of the cut is anesthetised first, then all the tissues encountered on the way are impregnated with the solution layer after layer.

In regional anesthesia the anesthetic solution is injected near the nerve or preferably into the nerve coming from some part of the body. Thus, conduction in the sensory nerve is temporarily disturbed, and the whole region is anesthetised (hence the designation of this form of anesthesia).

We also distinguish *anesthesia of the nerve plexuses* (for example, the brachial), which produces temporary loss of sensation throughout the area of distribution of the plexus branches, *anesthesia of the spinal roots* (so-called *paravertebral anesthesia*),

splanchnic anesthesia, and a number of other similar forms of anesthesia.

Many operations can be performed under infiltration and regional anesthesia. These forms of anesthesia are indispensable in operations on internal organs in which general anesthesia is contraindicated.

Novocain in a 0.25-0.5 per cent solution is usually employed for infiltration anesthesia, in a 1 per cent solution for regional and in a 2 per cent solution for plexal anesthesia. The marginal doses are 250 ml of a 0.5 per cent solution, 125 ml of a 1 per cent and 40 ml of a 2 per cent solution. However, smaller amounts are used as a rule.

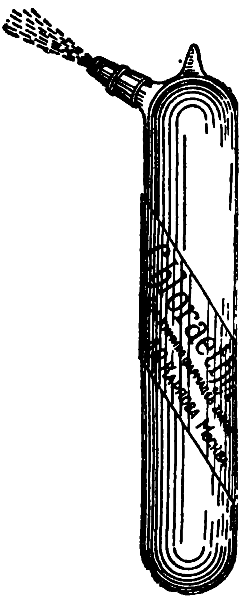


Fig. 100. Ampule of ethyl chloride

Much greater amounts of the solution — up to 1,500 ml and more — are used for administration of a 0.25 per cent novocain solution (anesthesia by A. Vishnevsky's method).

Novocain (procaine) intoxication is manifested in dizziness, excitement, unconsciousness, sleepiness, sometimes clonic spasms, stupor and cyanosis. It may end in death due to respiratory paralysis. In cases of intoxication the patient must be immediately given cardiacs; injection of 1-2 ml of a 20 per cent caffeine solution and camphor oil solutions is particularly recommended. In cases of respiratory arrest artificial respiration is administered, immediately then a vein is cannulated, the drugs are injected into the vein and a blood transfusion is made.

For anesthesia of mucous membranes and the peritoneum these parts may be painted with a procaine (or dicaine) solution (a 5 per cent solution for the peritoneum and a 10-20 per cent solution for the mucous membranes) or a 2 per cent dicaine solution.

Anesthesia for primary treatment of wounds. Primary treatment of wounds may be performed under local infiltration anesthesia which in many cases is superior to general anesthesia. In other cases, for example, in multiple splinter wounds, for examination of the entire intestinal tract in injuries of the abdominal cavity, in cases of thoracic cavity injuries and extreme excitement of the patient general anesthesia is more expedient.

PREPARING THE PATIENT FOR THE OPERATION

The time spent by the patient in the surgical department waiting for the operation is called the *preoperative period*, the time following the operation—the *postoperative period*.

Mental Prophylaxis. The patient's mental state is very important for the outcome of the operation and the postoperative period.

I. P. Pavlov's works have demonstrated the enormous role played by the central nervous system in pathological processes. His pupils have further elucidated this problem. It is sometimes possible to provoke a disease or alter its course by exerting an influence on the mind alone.

Especially important is the role of the word as a factor which influences the patient's condition and which must therefore be utilised in treatment.

Improper behaviour of the medical personnel, for example suggestion to the patient of a nonexisting disease (cancer, ulcer, etc.) may greatly harm the patient, cause loss of appetite, emaciation, appearance of pain, etc., and may even produce a clinical picture closely resembling the assumed disease (iatrogenic disease).

Mental depression renders very difficult the management of the patient in the postoperative period, lowers his resistance and is conducive to development of complications. Not infrequently patients manifest either too light-minded an attitude to the operation or a panic fear of it. They feel especially apprehensive if they happen to witness any severe or lethal cases in the surgical department.

Practical application of I. Pavlov's teaching in hospitals has resulted in elaboration of a protective and therapeutic regimen based on the following principles:

1) eliminating all stimuli which are unpleasant to the patients (odour of medicines, noise);

2) eliminating everything that interferes with normal sleep;

3) dispelling by persuasion the patient's anxieties and apprehensions, while he is waiting for the operation;

4) eliminating pain during operations, wound dressing, administration of medicines, etc.;

5) combining rest with physical exercise and work.

It would be wrong not to answer the questions the patient asks about the operation, but, on the other hand, the operation should not be described in detail. If the patient's question cannot be evaded, it is best to tell him that the operation is very desirable. Statements to the effect that the operation is not serious and completely safe may undermine the patient's confidence in the medical personnel. The patient is most favourably impressed by a calm and considerate attitude which makes him realise that the operation is necessary for his health.

Considerable attention is now devoted in surgical departments to the Pavlovian therapeutic and protective regimen which is aimed at sparing the patient all possible emotional stress. All factors connected with the patient's stay in the hospital and the surgical intervention are taken into consideration. From the organisational point of view this implies setting up special postoperative wards. The patient must not be kept waiting for the operation very long; he must not see any other operations or watch the preparations for his own operation.

A friendly and sympathetic attitude of the personnel is very important. The reception of the patient by the reception nurse on duty, and a kindly explanation by the ward nurse of the regimen of the surgical department must pursue the single aim of completely reassuring the patient and persuading him that he will be given the best possible care. The case histories must be kept under lock and key and must under no circumstances get into the hands of the patient; nor should the patient be told the results of the tests.

Lastly, in some cases it is desirable to suppress all mental activity of patients by preoperative and postoperative sleep therapy.

Physical Examination and General Preparation of the Patient. To produce better results and render surgical intervention safer, it is necessary to consider carefully the patient's general physical condition before the operation. The patient is therefore thoroughly examined and the method of anesthesia as well as of the operation is chosen with due regard for the condition of the internal organs (heart, lungs, kidneys, etc.).

It should be remembered that after surgical intervention the patient becomes more susceptible to infection, and the operation sometimes serves to aggravate his other ailments. If the patient has influenza, tonsillitis, furuncles, purulent wounds, or fever, the planned operation must be postponed. Only in urgent cases, for example, strangulation of hernia, intestinal obstruction and injury to internal organs, must the operation necessarily be performed. Since such patients are usually admitted immediately before the operation, only the heart, lungs and sometimes the renal function are examined. In such cases the operation

has to be performed even when the internal organs are in poor condition because only an operation can save the patient's life.

A preliminary examination of the patient consists primarily in assertaining the condition of his heart and lungs, which is achieved by auscultation, percussion, measuring the blood pressure and using X-ray tests, as well as by observing the patient to detect signs of dyspnea, cyanosis, or coughing, changes in the pulse, etc. The nurses must immediately report to the physician all the changes noted in the patient's condition. As a matter of fact, the nurses are in constant contact with the patient and can easily see any changes which may occur in his condition after his examination by the physician. These changes sometimes necessitate altering the method of anesthesia or of the operation; sometimes the operation has to be cancelled altogether. If the lungs were not adequately examined and upper respiratory catarrh was overlooked, the patient frequently contracts bronchitis and pneumonia after the operation, especially after anesthesia. If the patient has a serious heart disease, particularly degeneration of the heart muscle, the operation not infrequently leads to cardiac insufficiency. Patients with a diseased heart must be given preliminary treatment.

Preliminary treatment is also indicated in cases of chronic bronchitis and certain other pulmonary diseases. Such chronic ailments as syphilis, tuberculosis, malaria and diabetes mellitus must not remain unrecognised and uncontrolled.

To invigorate debilitated patients, especially those who have starved for a long time, they are administered glucose solutions rectally, subcutaneously or intravenously. The organism is thereby supplied with the necessary nutrient material in the most easily assimilated form. The patient is thus prepared over a period of 2-3 days. He is given daily, or twice a day, 20 ml of a 40 per cent glucose solution intravenously or 400-500 ml of a 5 per cent solution subcutaneously or per rectum. Simultaneously, for better assimilation of the glucose, insulin is injected subcutaneously in a dose of one unit per 1-1.5 g of sugar, but not exceeding 15-20 units per injection. Extremely dehydrated and anemic patients (with protracted vomiting, constriction of the esophagus or the pylorus) should be given subcutaneous injections of physiologic saline solution to replenish the body fluids and electrolytes.

Blood transfusions, as well as transfusions of native plasma or blood substitutes are made before very serious operations, especially to debilitated patients.

It is very important to record the temperature twice a day for several days before the operation. The temperature is a good index of the condition of the organism. If the fever is not connected

with the disease for which the operation is contemplated, it is best to postpone the operation until the causes of the fever have been ascertained or the affection responsible for it has been eliminated.

It is necessary to analyse the urine of every patient to be operated on. The most important from the surgical point of view is the presence of albumin, cellular elements (casts, red and white blood cells) and sugar.

Before some operations which necessitate prolonged confinement to bed the patients should learn to urinate and defecate in a bed pan, because they may have difficulties doing it after the operation.

If there are signs of inflammatory affection of the kidneys, the surgeon must abstain from the planned operation or administer safer, i. e., local anesthesia. It is very important to ascertain the presence of sugar in the urine because in diabetes mellitus surgical wounds heal poorly. Diabetics are predisposed to infection, their purulent processes often take an unfavourable course, there is local necrosis of tissues, the infection spreads and not infrequently causes septicemia. In treating diabetics one should therefore be particularly careful about surgical intervention.

Before the operation it is very important to examine the patient's blood (an erythrocyte count to detect anemia and a leukocyte count to detect leukocytosis) and, especially, the coagulability of the blood. Slow blood coagulation in hemophilia, liver disease, jaundice, etc., warrants the surgeon to postpone the operation or give it up altogether. To enhance the coagulability of the blood, the patient is administered, for several days before the operation, calcium chloride solutions intravenously, or human plasma intravenously or intramuscularly, or vitamin K (vikasol) is given per os; only after this may the operation be performed.

General Bath. Bodily cleanliness is particularly important for surgical patients. *For this reason they are given a general bath on the eve of the operation.*

However, there are exceptions to this rule. Patients with wounds or with open foci of suppuration should be given no bath because the water may bring dirt from the skin into their wounds. If the wound or purulent process is localised on an extremity and the patient is not in a very serious condition, a general bath or partial washing may be prescribed provided the dressing remains dry. Weak surgical patients (with peritonitis or purulent pleurisy), as well as patients with high fever or having hemorrhage (external or internal) should be given no bath. Moreover, no bath is prescribed in cases in which it is likely to cause pain (for example, in fractures of the bones of the trunk and lower extremities). Lastly, no bath is usually given before

urgent operations when any delay is dangerous (for example, before tracheotomy if the patient is suffocating).

After the bath the patient should be given clean linens.

Directly before being taken to the operating room the patient should be asked to urinate. Adult patients are given a subcutaneous injection of 1 ml of a 1 per cent morphine solution 25-30 minutes before the operation. One ml of a 1 per cent morphine solution is sometimes administered an hour and a half before abdominal operations performed under local anesthesia and the injection is repeated within an hour. After this the patient is calmer and is better able to tolerate local anesthesia and the operation.

Preoperative Diet, and Preparation of the Gastrointestinal Tract. Evacuating the patient's gastrointestinal tract is one of the important steps in preparing him for the operation. Patients who have food in the stomach are often observed to vomit under anesthesia. The vomit may enter the trachea and suffocate them. Moreover, with food in the gastrointestinal tract patients may involuntarily defecate on the operating table. Lastly, replete and distended intestinal loops are difficult to lay back into the abdominal cavity during a laparotomy. Repletion of the stomach and intestines during gastric and intestinal operations is particularly undesirable when it is necessary to open the wall of the stomach or intestine because their contents may infect the peritoneum. During the postoperative period a tendency to constipation is often observed and food in the digestive tract leads to abdominal distention. On the other hand, strict diet, starvation for a few days before the operation and administration of purgatives, especially to debilitated patients, also produce undesirable results. The benefits derived from these measures do not compensate for the weakening of the patients since starvation increases the acidity of the blood and tissues, which considerably aggravates the patients' postoperative condition.

On the eve of the operation the patients should be given lighter food. In some hospitals patients are administered one or two cleansing enemas—one on the eve and the other one on the morning of the operation. However, it is more advisable to administer only one cleansing enema, especially to weak patients. A full stomach, especially when it has to be operated on and cannot be purged normally (vomiting with a fecal odour in cases of intestinal obstruction, retention of food in cases of pyloric constriction), should be emptied before the operation by lavage. Only for operations on the large intestine (especially the rectum) should the preparation of the patients be more vigorous. In these cases the patients are administered a laxative and two enemas; immediately before the operation they are given an opiate to suppress peristalsis and to keep the bowels open.

For operations under spinal anesthesia patients are prepared as they are for general anesthesia because in some cases spinal anesthesia fails and general anesthesia has to be produced. Only administration of morphine is contraindicated before spinal anesthesia. During local anesthesia it is enough, in most cases, to cleanse the intestines with an enema. For operations on the pharynx and larynx the patient's stomach must be emptied since irritation of the pharynx during production of anesthesia may cause vomiting.

Care of the Mouth. Considerable attention should be devoted to the *care of the patient's oral cavity.* It is desirable and, before some operations in the oral cavity, even obligatory to extract carious teeth; the teeth must be brushed and the mouth rinsed. During the postoperative period oral infection may spread to the salivary glands and cause postoperative parotitis.

Preparing the Operative Field. In addition to general cleanliness, special attention should be devoted to preparing the part of the body where the operation will be performed. In the first place it is necessary to examine carefully the operative field. Not infrequently the operation has to be postponed because of skin lesions, such as scratches, eruptions, pustules, boils or abscesses. The nurse must report to the physician all the lesions observed. Lastly, the operation must often be cancelled if the patient has an open purulent process somewhere on the arms, face, etc. Of course, all the aforesaid does not apply to urgent or septic operations when such ailments do not warrant cancellation of the surgical intervention. In all other cases the skin diseases and purulent foci should be eliminated before the operation.

Hot baths are given for several days before the operation in cases in which the skin on the hands or feet is very coarse and dirty. The operative field is usually shaved on the day of the operation because earlier shaving may give rise to an inflammatory process (suppuration) at the site of small cuts on the following day and thus cause a break in asepsis. In addition to removing the hair and down, which render disinfection of the skin difficult, the contaminated superficial layers of the epidermis are scraped off during the shaving. It is necessary to shave off the hair not only in the operative field, but also all around it. Thus, for operations on the skull the whole head is usually shaved, while for minor operations only half of the head or the part closest to the site of operation is shaved. For operations in the region of the bridge of the nose the brows are shaved, for those in the region of the mouth, cheeks and chin—the moustache and beard; for operations in the axillary areas—the armpits; for abdominal operations—the pubic hair; for perineal and vaginal operations—the whole area of the perineum and pubis. If the shaving is painful, or if the operation is performed on

a small child, the hair should be shaved after the patient has been anesthetised for the operation. Nurses should be able to do the shaving. The site to be shaved is usually lathered. If the patient is shaved immediately before the operation, the shaving should be done without soap so as not to soften the skin or render its disinfection difficult. In these cases the skin may be moistened with alcohol. The razor must be held as shown in Fig. 101, the skin being stretched by the fingers of the left hand. Special importance is attached to shaving for cranial operations,

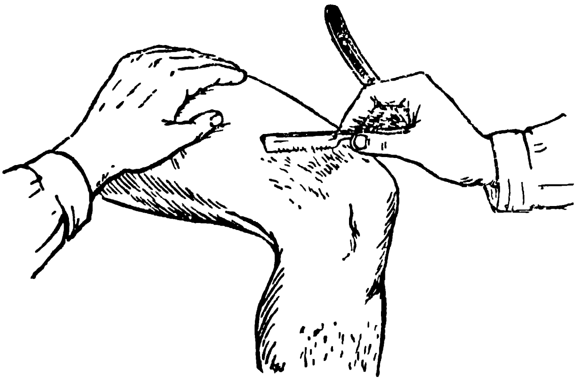


Fig. 101. Shaving

in which cases the shaving is done in the morning of the operation. The hair must first be removed with a clipper. The shaver should be careful not to cut the skin, shaving first with the shaft of the hair and then against it. The razor must be sharp and clean. During work it should be frequently wiped with alcohol. No razor used for septic cases should be used to prepare a patient for a clean operation. Before shaving and several times during shaving the razor should be stropped. Small cuts should be painted with iodine.

Final preparation of the operative field takes place either in the scrub-up or the operating room immediately before the operation. The skin is disinfected and tanned, being twice painted with 5-10 per cent of iodine tincture. In some hospitals the skin is cleansed with benzine, to remove the oily secretions, before it is painted with iodine. Other agents, for example, benzine solution of iodine or an alcohol solution of tannin, may be used instead of the tincture of iodine. With a benzine solution of iodine the skin is scrubbed for 2-5 minutes and with a 5 per cent alcohol solution of tannin for five minutes. Various aniline dyes which possess disinfecting properties are also employed. A 1 per cent alcohol solution of malachite green is the best.

Malachite green is cheaper than iodine and produces no burns on the face, neck, scrotum, in the anal region, etc.

The mucosa, for example, that of the mouth, is prepared by rinsing the mouth with a mild disinfectant (hydrogen peroxide, potassium permanganate, boric acid, etc.). To prepare the mucosa of the urinary bladder in cases of inflammation, the bladder is first washed out with rivanol, silver nitrate, and other disinfecting solutions. The mucosa of the rectum is prepared by enemas of a 1 : 1000 potassium permanganate solution.

Preparing for urgent operations. Preparation of emergency cases differs from the aforesaid considerably.

After a general examination to ascertain the condition of the patient's heart and lungs, and administration of cardiacs and anesthetics, if these are necessary, the grossly contaminated parts of the body are washed or rubbed down.

If it is impossible to prepare the digestive tract, especially if the stomach is filled with food, gastric lavage is performed.

The operative field is prepared by cleansing the skin with benzine, or 0.5 per cent ammonia water, and shaving the hair. Preparation of the injured includes certain special features. The dirt and blood are removed from the skin around the wound with the same agents. The wound is covered with a thick layer of sterile gauze, after which the hair is first clipped or sheared and then shaved dry, or with the skin moistened with hydrogen peroxide. The person doing the shaving must see to it that none of the hair gains entrance into the wound.

POSTOPERATIVE CARE

The time elapsing between the operation and the patient's discharge from the hospital is called the postoperative period. It varies between 7-8 days and several months, depending on the disease and the operation performed, as well as on the complications which may develop after the operation, sometimes because of improper care. To prevent and control postoperative complications requires very careful watching and thorough care of the patient.

During the postoperative period, especially immediately after the operation, the patient must be protected against cold air. This is particularly important since patients sometimes have chills after the operation. In such cases it is necessary to cover the patients with blankets particularly carefully and use hot water bottles.

Not infrequently patients sweat profusely after operations. In such cases they should be carefully dried and at the same time protected from cooling; the moist linens should be changed. Several towels, a basin for vomiting, and a bedpan should always be ready to hand at the patient's bedside. The nurses who are taking care of the patient must also have a syringe and solutions of various drugs available.

The patients' beds should be prepared particularly carefully. No creases or folds should be left in the sheets because the patients sometimes lie in one position without moving for several days on end, and the slightest crease gives them pain and produces decubitus-tissue necrosis and ulceration. The patients may be not particularly discomforted by the pressure of the creases in the sheets or other roughnesses of the bed because of the pains in the region of the surgical wound, and that may be the reason of bedsores.

Transportation of the patients. Careful and skilful transportation of patients alleviates their suffering and is especially important in certain conditions, for example, internal hemorrhages

and fractures. Each concussion or careless movement may sharply aggravate the condition of the operated patient and even cause his death (hemorrhages, emboli, thrombosis, etc.). To transport a patient, it is necessary to lift him easily, slowly and carefully, without abrupt movements, and thoroughly protecting the area of the surgical wound. The morbid part of the body should be held strongly but carefully. It is well to act in response to such commands as *lift*, *lower*, *forward*, *halt*. Only children (not under anesthesia) may be transported by one person. During transportation the patient should put one arm around the neck of the carrier and snuggle up against him, the carrier placing one arm under the patient's back and the other under his buttocks.

Fig. 102. Patient carried by two orderlies

A patient can be transported much more conveniently by two orderlies, both orderlies walking on the same side of the patient (Fig. 102). The patient should be lifted as follows: the first orderly places one arm, palm up, under the occiput and neck of the patient holding the patient's upper arm with his hand and placing the other arm under the patient's small of the back. The second orderly places one arm under the patient's sacrum and the other arm under his legs, preferably under the knees. Graver patients, especially with injured lower extremities, are best transported by three medical orderlies, one holding the head and upper part of the trunk, one—the pelvis and small of the back, and one—the legs.

Sometimes the patient is brought to the ward on a wheeled stretcher. The wheeled stretcher is placed obliquely or perpendicularly to the side of the operating table, on which the orderlies stand, the head end of the wheeled stretcher adjoining the foot of the operating table or, on the contrary, the foot of the wheeled stretcher adjoining the head of the operating table.

While transporting a patient under anesthesia, the orderlies should see to it that his arm does not hang on the side opposite to them; the patient's hands should be placed on his abdomen.

Especially grave patients (for example, with fractures) are

transported in bed which is placed on wheels by special supports or on trucks. The bed should be lifted on to the truck and taken off carefully.

Patient's position. After the operation the patient is usually placed on his back. This position is the most comfortable and restful, and some surgeons keep their patients in this position for several days after the operation, while others allow their patients to lie at their will, i.e., to turn in bed as they please. Frequently the patients themselves abstain from turning in bed too soon because these movements are painful, especially after an operation in the abdominal or thoracic cavities.

It is necessary to see to it that the patients should lie on an even surface; a rubber ring or pillow should be placed under the pelvis but so as not to produce a sag of the small of the back, since this may cause pain in it. Until the patient has come out of anesthesia his legs should be tied to the bed with a towel above the knees. But should the patient want to bend his legs upon awakening, there are no reasons to prevent him from doing it. A pillow or special bolster may be placed under the patient's flexed knees. In this position the abdominal muscles relax, and lying tires the patient less.

If the patient lies on his back for a long time, it is necessary to take care that he does not develop bedsores which usually appear in the area of the sacrum, the crests of the ilia, the heels and shoulder blades. Bedsores appear particularly soon in stout, as well as extremely emaciated, weakened and grave patients. To prevent bedsores, it is necessary, in addition to taking care of the bed, to rub the patient's skin at the points of pressure with camphor alcohol and to turn the patient on a side with the permission and on instructions of the physician.

Lying for a long time in a certain position very unfavourably affects old or extremely feeble patients, especially cancer patients. If such patients lie in a supine position for a long time, the lower lobes of their lungs are not properly inflated during respiration and therefore develop congestive and then inflammatory phenomena. If such patients cannot move by themselves, they should be helped from time to time to change their position. The weaker and older the patient, the more dangerous it is for him to lie in one position for a long time.

After most serious operations in the abdominal and thoracic cavities the best position is half-sitting with the legs slightly bent (Fig. 103). A special support which makes it possible to put the patient in a sitting or half-sitting position is attached to the bed under the head of the mattress (Fig. 104). To prevent the patient from sliding down, a pillow or bolster fastened to the bed are placed under his shanks and a stop is made for his feet. Sometimes the patient is put in a special bed (Fig. 105). An in-

flated rubber ring is placed under the patient's buttocks and pillows under his head and upper part of the body. The advantages of this position are: relaxation of the abdominal muscles, which alleviates pain in the surgical wound; reduced pressure on

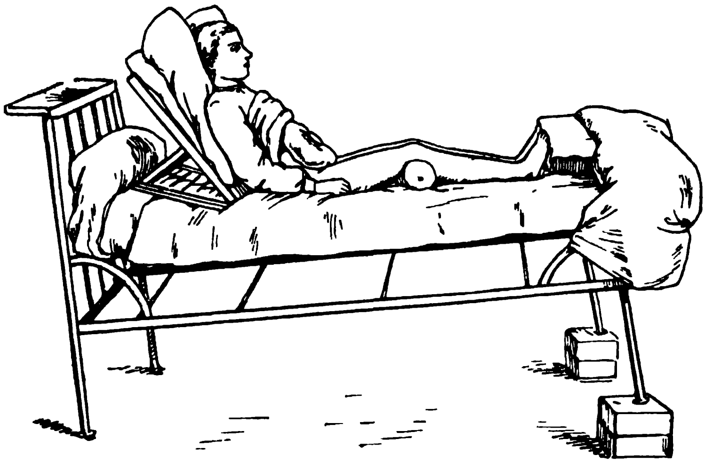


Fig. 103. Half-sitting position

the deep-seated organs (diaphragm). It facilitates respiration and the heart function; during infectious processes in the abdominal cavity the purulent exudate does not accumulate in the deep

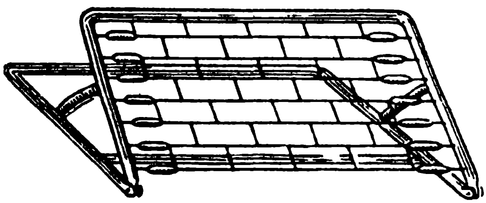


Fig. 104. Head support

pockets of the upper and posterior parts of the abdominal cavity but flows down, thus reducing the danger of diffuse peritonitis; lastly, this position is less tiring because all the muscles of the body and limbs are under a lesser strain. Moreover, it is more convenient to give the patient food and drink, and generally to care for him.

After some operations accompanied by extensive loss of blood patients are placed in a supine position without a pillow with the foot of the bed raised. After operations on the spine and in

injuries to the back and in the area of the buttocks the patients are placed in a prone position. The wounded will lie more comfortably if pillows are placed under the lower part of their shanks, the upper part of the chest and under the head. But in these cases bedsores may appear in the region of the crests of the ilia, the ribs and knee joints. After certain operations on the skull the patient is placed on his side, one leg, usually the lower one, is flexed in the knee and brought close to the abdomen, while the

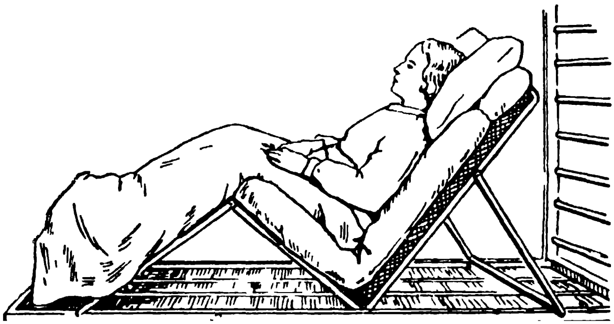


Fig. 105. Half-sitting position in bed with folding shield

other leg is extended. This position is rarely used immediately after the operation, but it is very convenient for turning the patient during the days to come. It is only necessary to watch that no bedsores appear in the area of the trochanter, the ankles, crest of the ilium and the costal arch.

Patient's rising after the operation. How soon after the operation may the patient rise? Great importance is attached to this question, especially after operations in the abdominal and thoracic cavities because of possible grave complications. Mild cases and patients operated on the neck, except goiter cases, are usually ambulatory patients.

The opinions of surgeons regarding patients after simple operations in the abdominal cavity and abdominal wall (appendectomy, herniotomy, etc.) somewhat differ, but most surgeons do not permit the patients to walk to the ward after such operations or to get out of bed too soon. These patients must be brought to the ward on a wheeled stretcher, although they are permitted to move in bed, turn and lie on a side from the very first day. Naturally, the patients after general anesthesia are an exception, since they have to lie in a supine position. Most of the patients are allowed to sit up in bed and get up, combining their rising with corrective exercises, on the second or third day.

After serious surgical interventions in the abdominal or thoracic cavities patients may not rise for 5-7 days, this period being sometimes even prolonged. In this respect the medical personnel should in some measure be guided by the way the patient himself feels. In cases in which early rising is not indicated, corrective exercises, especially breathing exercises, should be performed on the second or third postoperative day. The fear of some patients, who think that the suture may part if they rise soon after the operation, should be dispelled. The general rule should be that *the patient may get out of bed after the operation only by permission of the attending surgeon.*

Early rising and corrective exercises are particularly important for elderly patients. Prolonged immobilisation of such persons disturbs the circulation in the venous system and is conducive to formation of thrombi and dangerous, sometimes fatal emboli (see *Vascular Diseases*).

Patient's appearance. During the postoperative period the medical personnel tending the patients must carefully watch their condition, noting all the changes which take place. This will help to discern in good time the first signs of postoperative complications—pneumonia, peritonitis, suppuration of the wound, intestinal paralysis, retention of the urine, and dehiscence of the wound, especially after removal of the stitches.

In observing the patient attention must be paid to *his appearance* because it is not infrequently possible to identify developing complications by changes in the patient's appearance. One of the important symptoms is pallor which appears during internal hemorrhages, weakening of the cardiac function, fainting, etc. A flushed face often indicates the beginning of a fever and, especially often, postoperative pulmonary complications. A bluish tinge denotes respiratory difficulty and an icteric skin—a difficulty of bile outflow, affection of the liver or general septicemia. Lastly, in some cases the expression of the patient's face is characteristic of certain complications; for example, extreme pallor, a pinched face, sunken eyes with dark rings under them —the so-called Hippocratic face or peritoneal expression—indicate peritonitis, etc.

Temperature. During the postoperative period it is very important to watch the patient's *temperature* because most complications are attended with fever. The temperature should be recorded twice a day—morning and evening.

Slight hyperthermia (up to 37.5°C) during the first days following the operation occurs, as a rule, and is due to operative trauma. Nor is hyperthermia (up to 38°C), usually observed during the first 2-3 days after spinal anesthesia, of any great importance.

A sharp and prolonged rise in temperature beginning on the second or third day after the operation, especially if it is accompanied

by chills, may indicate a number of serious complications. The medical personnel must be able to interpret the hyperthermia correctly and to take the necessary measures. The temperature not infrequently rises during resorption of the blood accumulated at the site of the operation (postoperative hematoma), but protracted hyperthermia will in this case indicate an incipient infection—suppuration of the hematoma.

Hyperthermia in operated patients very often indicates pulmonary complications (bronchitis and pneumonia); in such cases it is usually accompanied by coughing, expectoration, dyspnea, respiratory difficulty, pain in the chest, and other signs.

The temperature may also rise as a result of an infectious process in the region of the wound (postoperative suppuration). In this case the temperature begins to rise 1-2 days after the operation and gradually increases being 0.5-1 °C lower in the morning than in the evening. Pain and inflammatory phenomena are usually noted in the wound. Timely ascertainment of the reasons for the fever is important because postoperative suppuration is eliminated much faster after a quick opening of the wound (removal of the stitches). Lastly, it must not be forgotten that hyperthermia during the postoperative period may also be caused by intercurrent general infections—various virus infections, tonsillitis, etc.

Cardiac function is one of the main characteristics of the patient's condition.

The intermediate medical personnel judges the activity of the cardiovascular system by the pulse, noting all its changes. Acceleration of the pulse, especially if the latter is weakened, is particularly important. *In a number of diseases acceleration of the pulse (more than 100 beats per minute) is one of the signs indicating aggravation of the patient's general condition.* Especially important is a progressive acceleration with a simultaneous weakening (thready pulse) and even disappearance of the pulse. It is most frequently observed during hemorrhages and diminution of the cardiac function. A slow pulse (less than 60 beats per minute) is very significant only after certain operations (on the brain, liver). A slow, tense pulse after an operation on the brain may indicate grave complications (compression of the brain).

Changes in the pulse necessitate a search for their causes and for measures to eliminate them; first of all—to stop the hemorrhages, to take measures against shock, to administer cardiacs in cases of heart failure, etc.

Organs of respiration. While watching the respiration, it is necessary to observe its type, because in some cases costal respiration appears as a result of a tight dressing applied to the abdomen, peritonitis, pains caused by an inflammatory process in the wound after gastric operations, etc. Abdominal and mixed

type of respiration are of lesser significance. It is also necessary to note the respiratory rate and appearance of dyspnea (during abdominal distention or pneumonia). The medical personnel must also notice whether the patient has pains in the chest, especially during respiration, whether or not he coughs up any sputum, the character of the sputum and whether or not it contains blood.

It is very useful to teach the patients, especially after cavitary operations, to do so-called breathing exercises, i.e., to make several deep inspirations every hour and expectorate, since sputum retained in the bronchi may cause pulmonary disease. The patients should be explained that such expectoration is not only harmless, but, on the contrary, is even most beneficial. If expectoration is very painful, the patient may, after minor operations (herniotomy, appendectomy) slightly press on the wound with his hand during expectoration, since this prevents vigorous muscular movement in the area of the wound and reduces pain. It does the patient well to inhale carbon dioxide several times a day during the first days after the operation.

Watching the nervous system. It is necessary to watch the patient to see whether or not he is conscious, dejected or excited, and whether or not he has headaches and sensory disturbances. The patient's nervous system is in large measure affected by postoperative pains. The pains are particularly intense during the first two or three days after the operation, following which they gradually abate. Pains continuing for a long time most frequently indicate inflammatory phenomena in the wound. Recurrence and increase in pains between the second and fifth day after the operation are especially characteristic of inflammatory phenomena.

It should be remembered that persons with a highly excitable nervous system poorly tolerate even slight pain and suffer more than those who are more patient. Good care, a friendly attitude of the medical personnel, complete physical and mental rest, and absence of any anxiety favourably influence the patients' condition during the postoperative period.

The patients are allowed to exercise their habits only if the latter are not at variance with the rules of hygiene; for example, smoking is prohibited, especially during the first days after the operation.

Postoperative insomnia is particularly distressing for the patients, especially during the first days after the operation, whereas it is precisely at this time that quiet and refreshing sleep is particularly important. Sometimes insomnia persists for a long period, especially in nervous patients, and greatly exhausts them. The causes of insomnia may be: overexcitement due to nervousness during the operation (especially under local anesthesia) and during the postoperative period (fear for the outcome), and post-

operative pains. To control insomnia, hypnotics—barbiturates—are given during the first days. To reduce the excitability of the nervous system, the patients are sometimes given bromides with valerian drops. Lastly, to relieve pain, narcotics (prescribed by the physician) are usually indicated during the first days after the operation. It is best to administer the narcotics—1 ml of a 1 per cent morphine solution or 1 ml of a 1-2 per cent pantopon solution—subcutaneously.

Morphine is usually administered in the evening following the operation but, if the patient has intense pains, it may be administered immediately after cessation of anesthesia, for the night and on the day after the operation. Usually no more than two injections a day are made. Administration of narcotics must be suspended within a few days after the operation to avoid habituating the patient to them. If narcotics have to be used for a longer time, morphine should be alternated with pantopon. If the patient insists on administration of narcotics, the latter are not infrequently replaced with physiologic saline solution (psychic influence). The medical personnel should be particularly careful about administering narcotics to chronic patients who have protracted pains and to nervous patients who usually become very rapidly habituated to narcotics. Pyramidon, codeine and promedole are used as weak analgesics.

But to eliminate postoperative pains it is first of all necessary to put the operated part in a comfortable and restful position because the more restful the patient's position, the sooner will the nerve endings cease to be irritated and the pains will disappear. Pain may also be caused by a tight, especially immobile bandage. In the latter case, if the patient complains of pain, the bandage must be examined to see if it is not too tight and if it does not need loosening.

Organs of digestion. It is very important to ascertain if the patient has nausea and hiccups, and if he vomits. ***Vomiting is frequently observed during the first day after anesthesia, but its appearance two days after the operation, especially simultaneously with hiccups, may indicate a grave postoperative complication, namely, peritonitis.*** Special attention should be given to the character of the vomit, to see if it contains blood and if it looks like coffee grounds, which indicates gastric hemorrhage. It is also important to make sure whether the patient discharges his gases and whether he has abdominal distention, because the latter is very painful. If the gases are not being discharged and the abdomen is distended, it is necessary to introduce a rubber tube 7-10 cm deep into the rectum; however, the tube must not be kept in the rectum for more than half an hour. If the introduction of the tube proves ineffective, a siphon enema or a small (two glassfuls) enema of a 10 per cent hypertonic common salt solution is administered

by prescription of the physician. The enema helps to discharge the gases from the intestines. The patient should be daily asked about his stool, its character and whether it contained blood or looked tarry (sign of gastric or intestinal hemorrhage). Since the patient is in a recumbent position, and is inactive, as well as for a number of other reasons, retention of the stool is most frequently observed after operations, and the patient is therefore given daily (or every other day) enemas during the first week following the operation. Patients do not have to be administered laxatives during the first postoperative days, except those who were operated on urgently without chance to purge the intestinal tract before the operation.

Urinary organs. The patients must be watched to see whether or not they urinate. Not infrequently patients cannot urinate in a recumbent position or because of pain in the wound caused by tension of the abdominal muscles during urination. In such cases a hot water bottle is placed on the region of the urinary bladder and the patient is given 0.5 g of urotropin per os; sometimes the patients are allowed to change their position. If the operation permits, the patient may rise. Should all these measures fail to help and the urinary bladder remains replete (patients complain of a replete bladder, or in some cases, especially when the patients are unconscious and have not urinated for a long time, a distended bladder is palpable over the pubis) the urine is drained artificially by means of a catheter (Fig. 106).

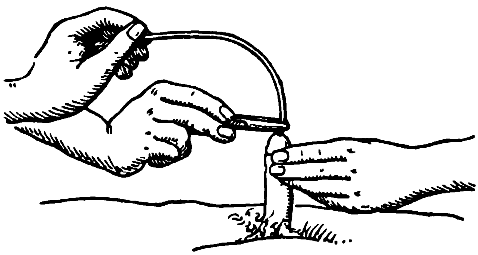


Fig. 106. Catheterisation with a soft catheter

Catheterisation is also employed to irrigate the urinary bladder, administer medicinal substances and obtain urine for analysis directly from the bladder (most frequently in women).

It should be remembered that it is not difficult to drain the urine but, if the rules of asepsis are not properly observed, infection may be introduced into the bladder and may lead to grave complications. Repeated and protracted catheterisation is particularly dangerous.

Withdrawal of the urine is not a safe procedure and must be resorted to only in cases in which it is indicated, for example, postoperative retention of urine, paralysis and diseases of the bladder.

Catheterisation is contraindicated during acute inflammation of the urethra.

To drain the urine, nurses use a soft catheter or prepare a semi-soft or hard catheters which are introduced into the urethra by a physician. The most widely used are catheters Nos 14-18.

The catheter is inserted by its rounded end near which there is a lateral oval opening. The external end of the catheter is expanded in the form of a funnel for introduction of the syringe tip during lavage.

Catheters are sterilised by boiling. By frequent boiling they lose their elasticity, become soft and unfit for use. After use catheters are washed with soap and water and are dried.

For catheterisation it is necessary to prepare: a sterilised catheter, sterile vaseline or glycerin, a rivanol solution, sterile dressing and a basin for the urine.

It is easier to drain the urine in women because the female urethra is short and straight.

The female patient assumes a supine position with legs parted. The external genitalia are washed with soap and water and the mucosa of the urethral opening—with a rivanol solution after parting the labia majora.

If there is a discharge from the vagina, the latter has to be douched.

After thoroughly washing her hands the nurse takes the catheter near its nozzle with a forceps, holding the external funnelled end with the fourth and fifth fingers. *She must not touch with her hands the parts of the catheter which will be introduced into the urethra.* Then nurse pours sterile vaseline oil over the catheter, holding it nozzle up, stands on the right side of the patient, parts the labia majora with the fingers of her left hand and introduces the catheter, grasping it with the forceps closer and closer to the external end until urine begins to flow.

It is more difficult to introduce a catheter into the male urethra because of its length and complex curved form. Difficulties may arise during the introduction of a catheter into the external opening of the urethra which may be constricted, as well as at the points of the expansion of the urethra in its bulbar part and at the very entrance to the bladder (hypertrophy of the prostate, spasm). No force whatever must be used during insertion of the catheter; the latter must pass absolutely freely. In case of obstruction it is necessary to wait until the spasm disappears. The patient must assume a supine position. After washing her hands the nurse stands on the left of the patient and retracting the foreskin washes with a rivanol solution the glans penis, especially in the region of the external urethral opening.

Holding the catheter with a forceps and coating its tip with glycerin or vaseline oil the nurse asks her assistant to hold the external end of the catheter and carefully inserts the catheter into the urethra. The nurse must see to it that no portions of the

catheter inserted in the urethra are touched by any hands or anything unsterile. If this has happened, however, the catheter should be boiled again and catheterisation resumed.

Grasping the catheter with a forceps closer and closer to its external end and holding the penis with the left hand at first vertically and then by drawing it upward and forward the nurse introduces the catheter carefully and smoothly, until urine begins to flow.

Observation of the urine consists in determining its qualities (turbid—in diseases of the urinary tract, icteric—in diseases of the liver, containing blood—after operations on the urinary tract).

After a number of operations, for example, on the kidneys, it is necessary to determine the amount of the urine excreted during the day. For this purpose the urine is collected into a special graduated vessel and, while emptying it at a certain time of day prescribed by the physician, the nurse records on a special sheet of paper the amount collected during the day. At the same time the amount of liquid consumed by the patient during the day is also accurately recorded.

Patient's diet. Before, during and soon after the operation the patient's organism loses a considerable amount of fluid, i.e., it becomes dehydrated. It is therefore necessary to replenish the lacking amount of fluid during the postoperative period. Dehydration of the organism is not infrequently manifested in tormenting thirst. After operations under local anesthesia the thirst can be very well quenched with water, warm or cold tea, mineral water, tea with lemon, etc. But the patients should be given to drink only if the stomach and intestines were not involved in the operation, otherwise they are usually not given anything to drink during the first days. If it is impossible to administer the requisite amount of liquid per os (1,000-2,000 ml per day), it should be administered in some other way. If the operation was not performed on the intestines, a physiologic saline solution (salt enemas of 100 ml of solution every hour or a rectal drip of 300 ml of the solution 2-3 times a day) may be administered through the intestinal tract. Moreover, during the first days after the operation it is permissible and advisable to administer up to 500-600 ml of physiologic saline solution subcutaneously or intravenously (twice a day).

To relieve the feeling of dryness in the mouth, the patients are allowed to rinse the mouth with water, provided they do not swallow it, or to wipe their lips and tongue with a moist cotton. If the patients do not feel nausea during the first six hours after the operation, they may be given to drink in small swallows every 15 minutes. Patients operated on the stomach, esophagus or the oral cavity are an exception (the diet of these patients will be discussed below).

The patients' diet should be watched particularly carefully. Their wardmates and relatives sometimes bring them entirely inappropriate food soon after the operation. The medical personnel must not allow this and must explain to the patients in good time the importance of their regimen.

Prolonged starvation after an operation is undesirable because it only weakens the organism. However, after any operation, especially on the gastrointestinal tract, abundant or coarse food may provoke the gravest consequences and even prove fatal. A diet is prescribed in accordance with the disease and character of the operation.

If the operation did not involve the abdominal cavity, the patients may resume their usual diet during the very first days after the operation, but must not eat coarse food or food which is difficult to assimilate (tinned food, sausage, bacon, etc.).

After operations in the abdominal cavity, but without incision of the stomach or intestines, the diet is restricted to avoid formation of gases (meteorism) and abdominal distention. In these cases the patients are given a so-called soft diet without milk (broths and soups with zwieback, jellies, baked apples, thin gruel and soft-boiled eggs); such patients are transferred to the common diet only on the seventh or eighth day.

A stricter diet is prescribed after operations involving opening of the stomach or intestines. During the first 5-7 days the patients are given only liquid food (broth, yolks mixed with water, scrambled eggs, thin jellies and fruit juices). The medical personnel must be careful about giving the patients milk because the latter produces abdominal distention; patients tolerate milk better when it is half-diluted with tea or boiled water. Gruelly food (soft boiled eggs, semolina, mashed vegetables) is allowed only on the seventh or eighth day, and zwieback on the tenth day, after which the patient is gradually put on the usual soft diet. The patients may be allowed to suck on hard fruit candy. After certain operations, mainly in the oral cavity, taking food per os is contraindicated. Such patients are fed through a feeding tube inserted through the nose.

Watching the bandage. Some incipient complications may be discovered and some prevented by watching the bandage, which is part of the duties of the medical personnel. The bandage may become loose and be displaced. In such cases it is necessary to reinforce it with a new bandage. If the bandage has completely come off the wound and the latter is exposed, it is necessary urgently to rebandage the patient. Sometimes the bandage is too tight; if it is on an extremity, the latter becomes edematous below the bandage, in which case the bandage must be loosened or replaced. If an ice bag is prescribed, it should be kept at the proper place. The attendants must see to it that the bandage does

not become soaked. If the bandage is soaked in pus, urine or other excretions from the organism, a new layer of cotton must be added to it. If the bandage is soaked in but little blood, an additional bandage may be applied on top; if it becomes sopping wet rapidly (which usually indicates considerable hemorrhage), it is necessary to take immediate measures to arrest the hemorrhage and summon a physician. It should also be remembered that if the bandage becomes soaked in a serosanguineous fluid it may serve as the first sign of a *serious postoperative complication—dehiscence of the abdominal wound with visceral prolapse.*

Bandages soaked in serosanguineous or serous fluid should therefore never be neglected. The reasons for the soaking should be immediately ascertained, especially after removing the stitches. Considering the danger of dehiscence of the wound, this complication should be identified as soon as possible. Only then will it be possible to render the patient the necessary assistance.

Changing the bandage. If there are no postoperative complications (fever, intense pain in the area of the closed wound, etc.), the first bandage should be changed on the seventh or eighth day, which usually coincides with removal of the stitches. However, for control purposes it is best to change the bandage sooner. Sometimes gauze tampons or drains are inserted in operative wounds during the operation for better draining of the blood, tissue fluid and pus. In cases of injury to small blood and lymph vessels over a considerable area, for example during excision of cancer of the breast. clean wounds are also drained. In such cases the tampons and drains are removed on the first or second day after the operation. From the abdominal cavity tampons are usually removed on the seventh or eighth day. In cases of septic operations (abscesses, phlegmons, etc.) the first bandage is changed on the second or third day after the operation, and if the bandage is considerably soaked in pus—on the day following the operation.

Removing the stitches. Most of the operations are accompanied by closing the skin wound. The stitches are removed after the edges of the wound have grown together. The period required for the wound to heal varies with the age and condition of the patient, and the time when the stitches are removed therefore varies with the patients. In most middle-aged patients the stitches are removed on the eighth day. In children and adults, after an operation on the face, the stitches are removed on the fifth or sixth day. After major abdominal operations, as well as in weak, emaciated patients, especially cancer patients, and if the stitches are subject to great strain (for example, after removal of large portions of the skin, etc.) the stitches are removed later.

Various complications, inducing cardiac failure, pneumonia, kidney affections, etc., may develop during the postoperative period.

Observation of the patient will enable the nurse to notice the first signs of pulmonary disease. These signs include fever, difficult and rapid breathing, flushed face, coughing, especially with sputum containing blood or pus, or having a rusty colour.

A weakened and rapid pulse may indicate cardiac weakness, in which case it requires urgent administration of proper cardiacs. The frequent retention of urine and the measures taken in such cases were already discussed above. The possible postoperative abdominal distention (meteorism) and the methods of aiding patients in this complication were also mentioned.

Operations in the abdominal cavity may be complicated by peritonitis, dehiscence of the wound and visceral prolapse. The last complication which usually develops after removal of the stitches is indicated by a very wet bandage. Such cases require an urgent reoperation.

Healing of the postoperative wounds may sometimes be complicated by accumulation of blood in the tissues (hematoma), hemorrhages from the wounds or suppuration in them.

Bedsores, i.e., necrosis of portions of the skin, which leads to formation of superficial or deep (reaching to the bone) ulcer, are not a rare complication. They may be simple or gangrenous, dry or with considerable purulent and putrefactive discharges. Bedsores are a result of prolonged confinement to bed in one position; they develop mainly at points long under pressure of the weight of the body. In patients lying on the back bedsores appear in the region of the sacrum, shoulder blades, elbows and heels, while patients lying on the side develop them in the region of the trochanter, crest of the ilium, elbows, thighs and ancles. In some cases bedsores develop at points of contact of skin surfaces, as for example the medial surfaces of the thighs at the knee joints, the skin under the breasts in females, etc. Development of bedsores is also fostered by an insufficiently even surface on which the patient lies, folds and crumbs on the sheet, moistening of the skin with urine, pus or other discharges at points of pressure. Bedsores appear particularly often in very thin, emaciated, weak patients, as well as in very stout ones. Development of bedsores is also favoured by a humid and perspiring skin, mainly in patients with rectal or urinary incontinence. Lastly, bedsores appear particularly rapidly and easily as a result of disturbances in innervation, for example, in injuries and diseases of the spinal cord.

To prevent appearance of bedsores, the patient's skin must be carefully watched. Gravo and all postoperative patients are placed on rubber rings, their points of pressure are examined several times a day and the skin is rubbed down with camphor or ethyl alcohol. A bedsoro begins with the appearance of a dark or red spot at the point of pressure, following which the portion of the skin becomes brown and insensitive; the superficial layer of the skin peels off and a section of necrotic tissues forms under which a suppurative process may develop. In most cases bedsores are a result of neglect on the part of the attending medical personnel. As soon as suspicious portions of skin appear, it is necessary to report them to the surgeon and obtain permission to change the patient's position. Treatment of a bedsore consists in painting the necrotic sections with a tincture of iodine, removing the necrotic tissues and applying dry aseptic dressings (after removal of necrotic tissues dressings with ointment are applied). Strict cleanliness is indispensable. General treatment consists in improving the patient's diet and timely physiotherapy.

HEMORRHAGES AND HEMOSTASIS

A hemorrhage is one of the most dangerous factors in an injury. The extent of the danger depends on the character of the wound (incised, contused, etc.) and a number of other factors—size of the wound, type of injured vessel (artery, vein), its position, etc.

If the blood flows to the exterior from the wound, it is an external hemorrhage; if the blood flows into the tissues or cavities (thoracic, abdominal), it is known as an internal hemorrhage. A hemorrhage into closed cavities sometimes remains to a certain extent *hidden* (internal); if it occurs into cavities which communicate with the environment (stomach, intestines, urinary organs), the blood may be discharged to the exterior and the hemorrhage becomes visible (external). In addition to the primary hemorrhage which occurs immediately after the injury, *subsequent or secondary hemorrhages from the wound* are not infrequently observed. The reasons for a secondary hemorrhage are: disengagement of a thrombus which formerly obstructed a vessel, purulent resolution of this thrombus, displacement of the ligature, damage to vascular walls by foreign bodies (shell splinters and bone fragments) and, lastly, destruction of vascular walls by a purulent process.

Since such hemorrhages are possible, the patient must be watched as long as the wound heals, especially during the first weeks, and in cases in which the wound does not cease to suppurate and does not heal for a long time during severe infectious processes.

Arterial, venous, capillary and parenchymatous hemorrhages are distinguished according to the nature of the injured vessel.

Arterial Hemorrhages. *Arterial hemorrhages are the most rapid and dangerous*; in injuries to the aorta and major arteries, for example, the subclavian, carotid or femoral arteries, the patient may die before he is administered any aid.

Usually arterial hemorrhage can be recognised without any particular difficulty; since arterial blood is saturated with oxygen

and has a bright-red colour, it is ejected in spurts and quickly soaks the dressing. Compression of the artery above (centrad) the wound *arrests* the hemorrhage.

Venous Hemorrhage. Venous hemorrhage is determined by the dark-red, almost black colour of the blood which is poor in oxygen and rich in carbon dioxide. The venous blood fills the wound in a continuous stream rather than in spurts. In such cases lowering the bleeding part of the body and compression of the vessels between the heart and the site of bleeding *intensifies the hemorrhage. During injuries to the major veins, especially on the neck, air may gain entrance into them* and produce a so-called air embolism which, as a rule, rapidly leads to death owing to the obstruction of the cardiac and cerebral vessels with air bubbles.

Capillary Hemorrhage. Capillary hemorrhage occurs in injuries to the minutest vessels (capillaries); no separate bleeding vessels can be seen, and the blood oozes out of the entire surface of the incision. The colour of the blood in this type of hemorrhage ranges between arterial and venous. A capillary hemorrhage usually stops spontaneously, due to clotting of the blood. It is dangerous mainly in cases of impaired blood coagulation (hemophilia, diseases of the liver, etc.).

Parenchymatous Hemorrhages. Parenchymatous hemorrhages not infrequently occur in *injuries to the internal organs which are rich in blood vessels* (liver, spleen, kidney, lungs); these hemorrhages are usually arrested with difficulty because the injuries involve arteries, veins and capillaries. Separate bleeding vessels may not be seen even in open wounds, blood oozing out of the entire surface of the injured organ.

If the human organism were unable to *arrest hemorrhages spontaneously*, the most insignificant hemorrhages would be fatal. Spontaneous hemostasis which depends on the ability of the blood to coagulate and obstruct the bleeding vessel with a blood from clot (thrombus) may occur in case of a capillary hemorrhage from small vessels and in some cases of parenchymatous hemorrhages, but it can not be relied upon during severe hemorrhages. If the blood pressure rises, the thrombus occluding the injured major vessel may be dislodged, causing a secondary hemorrhage.

Hemostasis. *Hemostasis may be preliminary, temporary or final.* The latter may be achieved only under hospital conditions. Before delivering the patient to the hospital measures are taken to produce *temporary hemostasis* otherwise the patient may die on the way to the hospital. The measures of temporary aid in hemorrhages include pressure applied to the vessel at the point of bleeding, pressure above the bleeding point, application of a tourniquet or elevated position of the bleeding area.

To arrest or at least to diminish hemorrhages of the limbs and head, the latter are placed in an elevated position. This method is particularly good in venous hemorrhages, for example, from the lower limbs, where it sometimes suffices to stop the bleeding.

Hemostasis by pressure applied to the bleeding point in the wound is employed in operations during any hemorrhage, whatever its nature; in these cases sterile dressing material is pressed to the bleeding point first and other measures are taken afterwards. If sterile dressing material is available, this method can be used

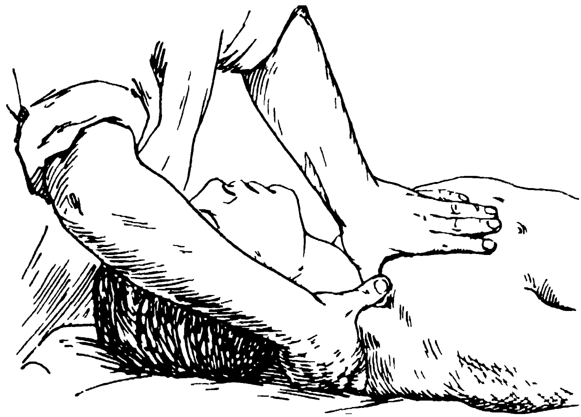


Fig. 107. Compressing the subclavian artery above the clavicle

for any hemorrhage. For this purpose the wound must be quickly exposed, its edges painted with a tincture of iodine, dressing material applied to the wound and pressed against the wound with the hand. If the hemorrhage does not cease and the patient has to be taken to a medical establishment, a pressure (tight) bandage may be put on. In such cases it is best to pack the wound with sterile dry gauze tampons and apply a pressure bandage.

Pressure of the artery anywhere above the bleeding point is one of the most convenient measures for temporarily arresting an arterial hemorrhage from the limbs, neck and head. This method does not violate the rules of asepsis and does not introduce infection into the wound (as may be the case when pressure is applied to the artery in the wound); it is easily employed under any circumstances and merely requires some knowledge of anatomy. It is most convenient to apply pressure at certain anatomical points where the arteries do not run deep and can be pressed against a bone. These are usually the points where the pulsation of arteries is palpable. The artery should be pressed with the thumb (Fig. 107) or the other four fingers (Fig. 108). If one hand tires,

it may be replaced by the other hand, but the pressure must not be weakened for a single moment. Application of pressure provides the time needed for preparing all that is necessary for a more

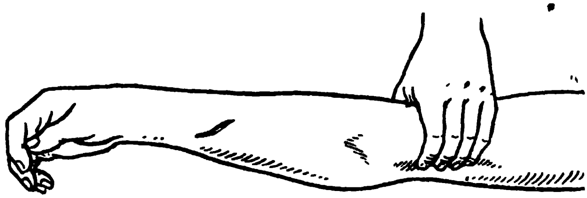


Fig. 108. Compressing the brachial artery with the fingers

suitable method of arresting the hemorrhage (sterile pressure bandage, tourniquet, etc.).

The *artery* is pressed at certain points shown in Fig. 109. The most *important points* are: the *groin* for the femoral arteries, *popliteal space* for the arteries of the shank, *axillary area and medial surface of the biceps muscle* for the arteries of the arm, *anterior surface of the neck in the middle of the sternocleidomastoid muscle* for the carotid artery and the *supraclavicular region* for the subclavian artery.

Fig. 109. Arterial pressure points

Application of a tourniquet is the most convenient method of temporarily arresting arterial hemorrhage from the limbs. The limb is tied with a tourniquet or rubber bandage above the bleeding point in the following manner: a towel or gauze bandage is wrapped round the limb (Fig. 110, *a*), the tourniquet or rubber bandage is stretched, wrapped several times round the limb over this lining and fastened. A tourniquet (Fig. 110, *b*) must be applied only tight enough to arrest the hemorrhage. When this is done all the vessels of the limb are completely compressed, the limb pales (does not grow blue) and the pulse in this limb disappears. Excessively tight compression may cause *paralysis* of the limb. *On the lower limb the tourniquet is applied to the thigh and shank, and on the upper limb—to the upper arm* (not in the middle, however, to avoid compressing the radial nerve, but

in the upper third of the upper arm) and to the forearm. The tourniquet must be applied for no more than one or two hours. If it is kept on for a longer time, it may produce necrosis of the limb or permanent paralysis of its muscles. If a patient with a tourniquet on is sent to the hospital, the escort should be told

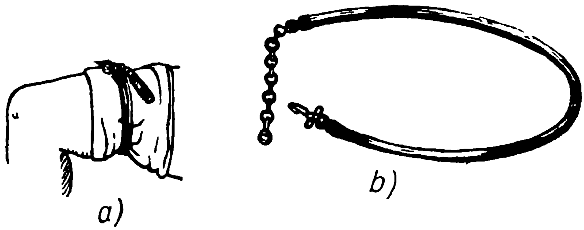


Fig. 110. Tourniquet and its application

when the tourniquet was put on and when it should be taken off. If for some reason or other the hemorrhage failed to be arrested during the aforesaid period, the tourniquet must be removed for some time (1-2 seconds) and put on again if the hemorrhage recurs. *A tourniquet should be applied only for profuse arterial hemorrhages.* It is useless and sometimes even harmful, especially

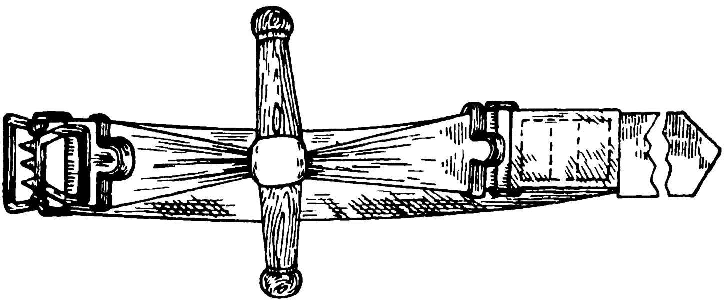


Fig. 111. Cloth tourniquet

if it is insufficiently tight, which in cases of venous hemorrhages only intensifies the bleeding.

A tourniquet is not infrequently applied to reduce bleeding during operations on the limbs, for example during aneurysms or amputations. In such cases the limb is for some time raised (for the backflow of blood) and a tourniquet is applied above the intended site of operation.

A special tourniquet can be easily replaced with the rubber tube from Esmarch's can.

The limb may also be tied off with a piece of cloth, rope, strap, kerchief, etc. In such cases the following must be done (see

Fig. 112): the kerchief is tied very freely and then a stick or some piece of wood is placed in the loop and turned until the hemorrhage is arrested. Such tourniquets are painful and must therefore be padded with something. Excessively tight compression and improper application of coarse, cutting tourniquets (for example, ropes) may injure the nerves and produce paralysis.

The *main errors* in applying a tourniquet are: application without sufficient reason, too far from the wound, application to the bare body, too weak or too strong compression, and failure to indicate that the patient has a tourniquet on.

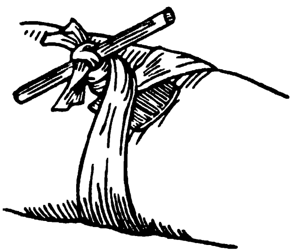


Fig. 112. Tourniquet

Final hemostasis may be achieved by mechanical, chemical or biological methods.

Mechanical Methods of Hemostasis. *The mechanical methods* of hemostasis must be regarded as the most important. *The elevated position of the bleeding area, tamponade of the wound and pressure bandages* have already been described. It should be noted that they are the principal forms of aid in capillary and venous hemorrhages. For example, hemostasis with the aid of a *tamponade* is not infrequently used in hemorrhages from the nasal cavity, the vagina, bony cavities, etc. The tampon is removed after different periods of time, most frequently within two days but sometimes even within two weeks.

Ligature of the vessel (application of a thread to constrict the lumen of a vessel) is the most reliable method of final arresting of a hemorrhage. However, the danger of a secondary hemorrhage from the infected wound, as well as the difficulty of finding the bleeding vessel in the wound sometimes force the surgeon to resort to *ligating the artery somewhere above the bleeding point.* This is an *operation of ligating the vessel* at a chosen point. The vessel should be ligated where it is more accessible for the operation and as close to the wound as possible. Silk and, for small vessels, catgut are most frequently used for this purpose. Wherever it is difficult to isolate the vessel amid dense tissues, for example, on the skin of the head, instead of a simple ligature the vessel is sometimes grasped together with the soft tissues by stitches.

Physical Methods of Hemostasis. The *physical methods of arresting hemorrhages* consist in applying hypo- or hyperthermia. Local application of cold (ice bag) causes local constriction of the vessels and thereby favours hemostasis; in case of subcutaneous hemorrhages ice must be used very cautiously and with intervals because it may lead to necrosis of the skin.

Hyperthermia is applied in the form of *cauterising the bleeding point* (mainly during capillary hemorrhages in patients with poor blood coagulability).

During hemorrhages from the cavities hot (50-60°C) saline solutions are not infrequently used.

Electrocoagulation. To stop the bleeding from small vessels during operations, an electric knife is frequently used. As a result of heat production during the passage of high-frequency currents through the patient's body at the point of application of the active electrode the proteins of the tissues coagulate.

Chemical Methods of Hemostasis. There are external and internal *chemical methods of arresting hemorrhages.*

External local hemostatic agents may be used during capillary hemorrhages, but they are easily replaced with a tamponade.

A tamponade with a 3 per cent hydrogen peroxide or a (1 : 1,000) adrenalin solution is often used. The former is conducive to coagulation of the blood and the latter acts as a vasoconstrictor.

Internal hemostatic agents act either by *constricting the vessels* or by *enhancing blood coagulation.* The former group includes *ergot preparations*: ergotin subcutaneously, goldenseal (Extractum fluidum Hydrastis canadensis) 35-40 drops per os, adrenalin (1 : 1,000; Adrenalini 0.5 ml subcutaneously). These agents are used mainly during internal hemorrhages inaccessible to other forms of treatment (uterus, lungs, stomach, etc.).

The latter group of *agents enhancing blood coagulation* is much more important. These agents include calcium chloride administered per os (10 per cent solution in doses of one tablespoonful) or intravenously (5-10 ml of a 10 per cent solution). Calcium solutions must not be administered subcutaneously because they produce necrosis of the skin.

Biological Methods of Hemostasis. To enhance blood coagulation during internal parenchymatous hemorrhages *normal horse serum* is administered subcutaneously in doses of 20-40 ml. If normal horse serum is lacking, one of the *therapeutic serums* (antidiphtherial, antitetanic) may be administered in the same doses.

The potent agents which enhance blood coagulation include vitamin K (vikasol), and its derivatives administered intramuscularly in a dose of 5 ml of a 0.3 per cent solution.

A very good method of enhancing blood coagulation is *transfusion of small amounts of blood* (50-150 ml) which will be discussed below. As a local hemostatic agent, mainly for parenchymatous hemorrhages, free transplantation of tissues (strips of muscle, omentum, fascias), as well as fibrin films, fibrin cotton and other preparations obtained from the blood plasma, are used.

Acute Anemia Caused by Massive Hemorrhages. The *danger of a hemorrhage to the life of the patient depends primarily on the amount of blood lost.* A hemorrhage involving the loss of 200-400 ml

of blood may scarcely affect the general condition of an adult, whereas a blood loss of 1,000-1,200 ml is dangerous. The rate of bleeding is of great importance; especially dangerous are hemorrhages from the major arteries. Age, the patient's general condition and sex are important as regards the results of the hemorrhage. For example, a loss of 250-300 ml of blood is fatal for a one-year-old child. Women endure hemorrhage more easily than men do.

Regardless of the nature of the hemorrhage (external or internal) *the clinical picture of acute anemia due to the hemorrhage*

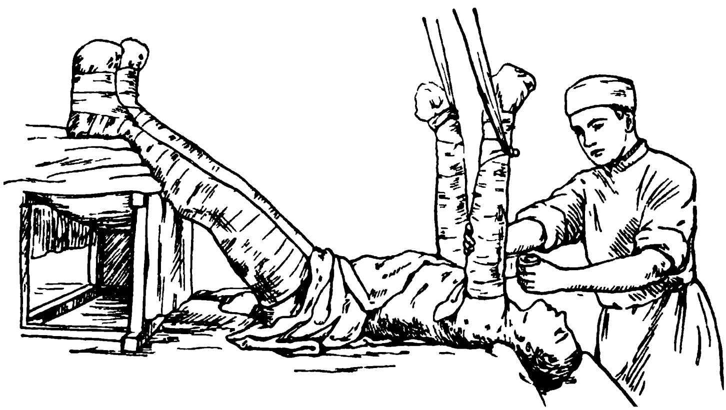


Fig. 113. Autotransfusion

will be characteristic; in many cases of internal hemorrhages it is only because of this picture that a hemorrhage may be suspected. The patient wants to drink, complains of weakness, of things going dark before his eyes and dizziness, begins to yawn and sometimes faints. Examination of the patient reveals pallor, especially evident on the extremities and ears, sometimes cyanosis, cold limbs, weakening, acceleration and sometimes complete disappearance of the pulse. If the hemorrhage continues, convulsions and dyspnea appear, the pupils become dilated and the patient may die. Death caused by a hemorrhage is most frequently due to an insufficiency of fluid in the vessels, poor blood supply to the brain and heart, and a disturbance in the gaseous exchange. To combat these phenomena, *after arresting the hemorrhage*, attempts are made to administer as much liquid to the patient as possible; physiologic saline solution or a glucose solution is administered intravenously, subcutaneously, or rectally in drips or enemas.

The circulatory failure affects, in the first place, the vital centres of the brain and heart. Measures must therefore be taken

mainly to supply these areas by means of a so-called *autotransfusion* of the blood. The patient is placed in a supine position with head lowered, his extremities are raised, tightly bandaged from end to end with elastic rubber bandages (Fig. 113) and a weight (a bag with sand) is placed on his abdomen. Thus the blood from the extremities is pressed towards the heart and brain and may suffice for the diminished blood stream. These are temporary measures enabling the organism to equalise the loss of blood. In addition, measures must be taken to sustain cardiac function, for which purpose cardiacs—camphor and caffeine—are administered subcutaneously, physiologic saline solution is injected and a blood transfusion is made.

Infusion of Solutions. During acute anemia it is, first of all, necessary to arrest the hemorrhage by one of the methods mentioned above. Death from a hemorrhage is in certain measure due to an insufficiency of fluid in the blood stream, poor supply of the heart and brain with blood, and disturbances in the gaseous exchange. To combat these phenomena, attempts are usually made to compensate for the shortage of fluid in the organism by an abundant administration of it; the patient is given a lot to drink if he is conscious; if unconscious, he is administered physiologic saline enemas and rectal drip and given subcutaneous or, best of all, intravenous physiologic saline infusions.

Fig. 114. Bobrov's apparatus

To infuse large amounts of fluid subcutaneously or intravenously, a system of bottles of Bobrov's apparatus (Fig. 114) is used. The latter consists of a graduated glass bottle closed with a rubber plug (to prevent the plug from falling out, it is fastened to the neck of the bottle with a special lock), glass and rubber tubes, a needle and a balloon. Two glass tubes, a long one reaching the bottom of the bottle and a short one, pass through the plug. Before use the apparatus is examined as follows. Some fluid (for example, saline solution, boiled water, etc.) is poured into the bottle, the bottle is tightly plugged, the plug is fastened with the lock, the short glass tube is connected with the balloon and a rubber tube with a needle on the end is connected with the long glass tube. Compression of the balloon pumps air into the upper part of the bottle, the air presses on the liquid and drives it through the rubber tube into the needle. The fluid must flow out of the bottle in a strong and even stream. All parts of the apparatus, except the balloon, are sterilised before use, ac-

cording to the rules for sterilising syringes. After carefully washing the hands the nurse rinses the bottle with sterile physiologic saline solution, spills it out and pours into the bottle sterile physiologic saline solution heated to 40°C by immersion in hot water. After carefully washing the hands again the nurse closes the bottle with the plug. Under no circumstances may the glass tubes, inserted in the bottle, or the needle be touched by hand; it is best to hold the needle by grasping the cannula at the point where it is connected with the rubber tube.

After the requisite portion of the patient's skin has been disinfected with iodine, the tube leading to the needle is filled with the fluid by compression of the balloon. To get rid of all the air bubbles, the needle is raised, tip upward, until the fluid begins to run out of it in a stream. After this the tube is compressed so that the fluid may not be wasted and the tip of the needle is introduced into the subcutaneous tissue, most frequently of the anterior surfaces of the thighs.

As soon as the person administering the infusion makes sure that the needle has been correctly inserted he begins gradually, under low pressure, to introduce the solution into the subcutaneous tissue merely by lightly pumping air with the balloon. It is not desirable to infuse more than 500 ml of solution in one place in a single dose. A swelling usually forms at the point of infusion; for faster resorption this place should be lightly massaged.

BLOOD TRANSFUSION

Blood transfusion was given scientific substantiation and began to be widely used only after the groups of human blood had been established and the conditions of blood compatibility and incompatibility in different people had been ascertained.

The Soviet scientists S. Spasokukotsky and A. Bagdasarov elaborated methods of preserving the blood and improved the techniques of transfusion

Blood transfusion has become an accessible operation, but to prevent grave complications and produce good results it requires strict observance of certain rules. These include sterility in preparing the apparatus, precision in determining the blood groups, proper preservation of the serums and observance of other rules which at times seem "trifling".

Everything connected with blood transfusion must be done under conditions of strictest surgical asepsis. The apparatus and instruments must be carefully examined.

Blood groups. Grave changes in the composition of the blood constitute the main danger of blood transfusion. Heterologous red blood cells of the transfused blood agglutinate and then dissolve (hemolysis). The patient develops dyspnea, cyanosis, hemoglobinuria, and bloody flux, loses consciousness and may die.

The blood of all people may be divided into four groups, according to its agglutination properties: first group—$0\ \alpha\beta$ (I), second group—$A\beta$ (II), third group—$B\alpha$ (III) and fourth group—AB_0 (IV).

The agglutination reaction may be regarded as a combination of the agglutinins found in the serum (designated by the letters α and β) with the agglutinogens found in the erythrocytes (designated by the letters A and B).

Agglutination results when the agglutinin of the recipient's serum comes in contact with the corresponding agglutinogen of the donor's erythrocytes, for example, agglutinin α with agglutinogen A or agglutinin β with agglutinogen B.

For short, the groups are designated by figures and letters.

The blood of the first group 0 (I) contains no agglutinogens. It is not agglutinated by the serum of the other groups. The blood of the people of this group may be transfused to anybody (universal donors), but it contains agglutinins α and β. It follows that the blood containing agglutinogens A (second group), B (third group) or A and B (fourth group) may not be transfused to a person with blood of the first group; only the blood of the first group which contains no agglutinogens may be transfused to this person.

Group A (II) contains the agglutinogen of erythrocytes A, while the serum contains agglutinin β. Consequently, only the blood which contains no agglutinogens (i.e., of the first group) and the blood which contains agglutinogen A (i.e., of the second group) may be transfused to the recipient of this group; nor may the blood containing agglutinogen B (i.e., the blood of the third and fourth groups) be transfused; the blood of the second group may not be transfused to a recipient of a third group because the third group contains agglutinin α which corresponds to agglutinogen A of the second group, and may be transfused to a recipient of the fourth blood group, because the blood of this group has no agglutinins at all.

A person with the third group of blood B (III) may receive the blood of the first group because it does not contain any agglutinogens at all; the blood of the second and fourth groups cannot be transfused to this person because it contains agglutinogen A of the erythrocytes, which corresponds to agglutinin α of its serum. The blood of the third group may be transfused to a recipient of the third and fourth groups because the blood of these groups does not contain corresponding agglutinins of the serum.

Lastly, the blood of the fourth group AB (IV) may be transfused only to a recipient of the same group because this blood contains agglutinogen of both types and does not contain any agglutinins of the serum; it follows that any of the other groups which contain any of the corresponding agglutinins (α, β or $\alpha\beta$) will agglutinate the blood of the fourth group. Contrariwise, the recipient of the fourth group may receive the blood of any group because the serum contains no agglutinins which could agglutinate the erythrocytes of any blood group.

Determining the blood group. The blood group must be determined in order completely to exclude any possibility of error. It is therefore very important carefully to learn the techniques of blood transfusion. The double reaction, i.e., determination of the blood group by standard serums (direct reaction) and determination of the serum group of the blood being examined by means of standard erythrocytes (reverse reaction), is the best method. More often than not only the direct test is used, but it is desirable to perform it twice with two different series of serums.

Everything required for taking the blood must be prepared beforehand, namely Frank's needle, sterile cotton, alcohol or other, pipettes, test tubes, stand for the test tubes and spirit lamp.

To determine the blood groups, the following things are prepared:

1) standard serums of groups 0 (I), A (II) and B (III);
2) slides or porcelain plate;
3) small glass or stand for serum ampules;
4) physiologic saline solution;
5) iodine tincture, alcohol, cotton, four pipettes, three glass rods and three little glasses.

The conditions under which the blood groups are determined — good lighting and temperature of 15-25°C—are very important. The blood must not be examined at temperatures below 10°C and above 30°C because the results may prove wrong.

The documents showing the different blood groups must be very accurate. The necessary data bearing ordinal numbers are recorded in a special journal. The first and last names of the person being examined, the results of the reactions and conclusion about the blood group are recorded. The latter is also recorded in the case history and other necessary documents.

The standard serums prepared in institutes of blood transfusion are kept in a dark dry place under lock and key at a temperature not exceeding 20 C. The blood group, titre and period of time for which the given serum is valid are inscribed on the ampules.

The person working with standard serums must be sure of the specificity of the serum and its titre. In case of doubt the serum must be checked upon. One ml of serum siffices for 20-25 examinations.

A large drop of each standard serum of groups 0 (I), A (II) and B (III) (Fig. 115) is placed at definite points of the slide or clean white plate, the groups of serum being indicated in pencil. A separate pipette is taken for each serum; the pipettes are also marked and used only for taking the corresponding serum after which they are immediately placed in the glass bearing the mark of the corresponding group.

It is always best to place the drops of serum in a definite order (the drop of the third group on the right, of the second group in the middle and of the first group on the left), after which each drop of the serum is mixed with three drops of the patient's blood taken from the fleshy part of the finger

The blood is drawn with Frank's needle from a finger wiped with a cotton soaked in alcohol or ether. Sometimes the blood is taken from a helix or drawn with a syringe from a vein, or, lastly, with the aid of a tampon from the surgical wound.

Drops of the blood are placed with the aid of glass rods next to the drops of serum. Each drop of blood the size of a pin point

is introduced into the drop of standard serum and is mixed with it. Separate rods for mixing each standard serum are used.

The reaction is watched for five minutes by the clock, the plate or slide being lightly shaken.

After three minutes a drop of physiologic saline solution is

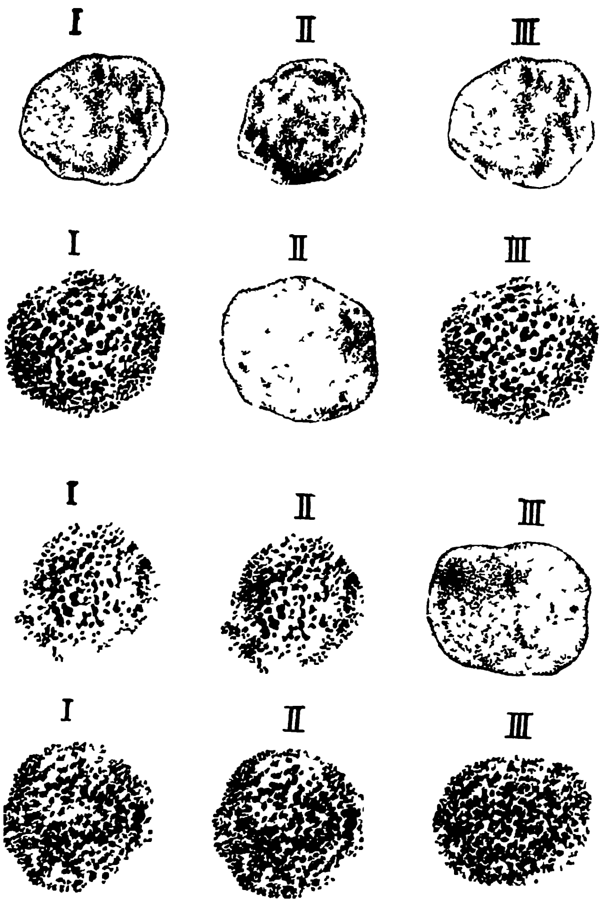


Fig. 115. Determining the blood groups

added to each drop of the mixture, the latter is mixed again and the final results are evaluated.

The reaction is studied against a white background. In the presence of agglutination red clumps resembling particles of brick dust are formed; the serum becomes transparent and colourless.

Absence of clumps and uniform turbidity of the mixture indicate absence of agglutination (Fig. 115).

If no agglutination occurs in any of the drops, it means that the patient's blood belongs to the first group; if the blood agglutinates with the serum of the first and third groups and does not agglutinate with the serum of the second group, it is blood of the second group; if, on the contrary, it agglutinates with the blood of the first and second groups and does not agglutinate with the blood of the third group, it is blood of the third group; lastly, if it agglutinates with all three serums, it means that it belongs to the fourth group. The blood group of the donor is determined in the same manner.

The results may be recorded with the aid of a table in which the presence of agglutination is marked by a plus sign (+) and absence of agglutination by a minus sign (—). The column on the right contains the conclusion about the blood group.

	Standard serums groups			Blood group
	O(I)	A(II)	B(III)	
Blood tested (erythrocyte)	—	—	—	O(I)
	+	—	+	A(II)
	+	+	—	B(III)
	+	+	+	AB(IV)

In doubtful cases the examination is repeated with another series of serum, a reverse reaction is performed or a more sensitive reaction in test tubes is used.

It is necessary to have fresh, sufficiently active serums, and accurately to observe the technical rules for determining the groups, i.e., to place the drops of serum properly, marking the groups on the glass in a definite order, and use clean pipettes and glass rods for each individual serum.

Sometimes agglutination is established where there is really none (pseudoagglutination). This is observed in cases in which the temperature is below 10°C, or condensation of the serum or drying of the drop takes place, and in cases of stale suspension of erythrocytes and insufficiently clean vessels (increased acidity of the medium). To make sure whether there is any pseudoagglutination, the drop of serum is dissolved with physiologic saline solution and, being slightly heated, is mixed again.

The appearance of agglutination may be presented in the following cases: a rise in the temperature above 30°C, weak titre of the serum, excessive number of erythrocytes and insufficiently long observation.

Special blood properties described in rare cases make it possible to distinguish subgroups among the A (II) and AB (IV) groups.

Rh (Rhesus) factor. The blood of 85 per cent of the people contains an antigenic Rh factor, i.e., they are Rh positive; 15 per cent of the people do not have this factor, i.e., they are Rh negative.

The antibodies against this factor appear as a result of repeated transfusions of Rh positive blood or during pregnancy of a Rh negative woman carrying a Rh positive fetus. During the formation of such antibodies a severe reaction to the transfusion may occur. It is therefore necessary to ascertain before the transfusion if there were repeated transfusions before and if they produced a reaction, and if the woman had ever had premature labour or a stillbirth. If sensitivity to the Rh factor is suspected, special tests are made.

To conduct such a test, 2-3 ml of the recipient's blood (without citrate) is taken into a test tube. After coagulating the blood, separating the clot from the walls with a glass rod and centrifuging it the recipient's serum is obtained. Two drops of this serum and one drop of the donor's blood are mixed in a Petri dish and are placed in a water bath (at a temperature of 42-45°C) for 10 minutes.

The presence of agglutination indicates that this blood must not be transfused. A negative result does not exclude the possibility of sensitivity to the Rh factor and, if the patient's anamnesis contains indications of his sensitivity, only Rh negative blood is transfused to this patient, this property of the blood being shown in the blood certificate.

Blood compatibility. Before the transfusion a blood compatibility test is made by mixing a drop of the patient's serum with a drop of the blood to be transfused. In the absence of agglutination the blood is considered compatible.

Before the transfusion it is necessary to perform a biological test, i.e., first to inject 10-15 ml of the blood into the patient's vein and wait for five minutes. If there is no reaction, the injection of 10-15 ml of blood is repeated. In the absence of a reaction—chills, pains in the small of the back, vomiting, cold sweat and a drop in the pulse rate—the transfusion may be continued.

EFFECT OF THE TRANSFUSED BLOOD

The transfused blood exerts a replacing action on the organism which is particularly valuable in cases of blood insufficiency caused by hemorrhage and in shock.

Owing to this replacing action the blood pressure rises, the blood circulation improves, the vascular tone is enhanced and the respiratory surface of the blood increases. Proteins, plasma, hormones and other substances which are of enormous importance to the organism are introduced with whole blood.

Moreover, the blood possesses a stimulating effect which evokes improved functioning of the hemopoietic organs and by enhancing metabolism increases blood coagulability, etc. For the aforesaid purpose it is administered in lesser amounts (100 ml). As was already mentioned, blood transfusion is also important as an influence on the reflex mechanisms owing to stimulation of the angioreceptors and the resulting rise in vascular tone.

INDICATIONS AND CONTRAINDICATIONS FOR BLOOD TRANSFUSION

One of the basic aids in acute and chronic anemia, as well as shock, hemophilia, etc., is transfusion of 225-450 and more ml of blood. In these cases not one medical agent can compare in effect with blood transfusion.

Blood transfusions are also made to exsanguinated and emaciated patients before operations. Blood transfusions are observed to produce good results in patients with purulent and septic processes, anaerobic infection, a number of internal diseases (hemolytic anemia and other diseases of the hemopoietic organs, hemorrhagic diathesis, avitaminosis. cachexia) and in certain infectious diseases.

Severe disorders of the cardiac function (heart failures in the decompensation stage), grave affections of the kidneys and liver, active forms of tuberculosis, thrombophlebitis, pneumonia and hypertension are contraindications for blood transfusion.

Complications. Aggravation of the patient's general condition, compression in the chest, feverishness, headache and pains in the abdomen and in the small of the back, appearing after infusion of 25-50 ml of blood, indicate blood incompatibility. The blood transfusion is discontinued. Appearance of similar symptoms 30-40 minutes after the transfusion denotes Rh incompatibility of the blood.

Hemolytic shock must be treated with transfusion of the same group of blood and must begin at the appearance of its first symptoms; in cases of Rh incompatibility it must be treated with transfusion of Rh negative blood. If the patient is in a grave condition he should be bled (200-400 ml) before the blood transfusion.

Blood transfusion not infrequently produces a post-transfusion reaction: fever, chills and weariness. In cases of a mild or moderate reaction the temperature rises to 37-38°C for a few hours, whereas in cases of a strong reaction the temperature rises to 39°C and higher, and the patient has intense chills. Transfusion of incompatible blood may produce a very grave complication—post-transfusion shock. The pulse becomes rapid and the face flushed, the patient grows uneasy, feels a compression in the chest and pains in the lumbar and abdominal regions, begins to vomit,

his blood pressure drops and the cardiac function weakens, he breaks out in a cold sweat, and urinates and defecates involuntarily. The result may be fatal.

As soon as it is established that incompatible blood has been transfused, the patient should be immediately given a transfusion of 250 ml of compatible blood, should be kept warm, given a subcutaneous injection of 1 ml of a morphine solution, an intravenous injection of glucose and physiologic saline solution, or a drip enema. A novocain paranephral block, gastric lavage, hot baths and abundant drinking of alkaline water are additionally indicated.

Dyspnea, a feeling of suffocation, general uneasiness and sometimes loss of consciousness may occur during another grave complication—air embolism. The patient must immediately be placed in a position with the head of the operating table or bed lowered and must be administered artificial respiration and cardiacs.

Methods of transfusion. Blood may be transfused either directly from the donor's vein into the patient's vein (direct transfusion) or it may be first processed, stored and administered from some vessel (indirect transfusion). Direct blood transfusion from the donor's vein into the patient's vein is effected by means of special apparatus.

The indirect method of blood transfusion, i.e., with an addition of a conservant medium—sodium citrate, is simpler and is used more frequently. The apparatus must be very carefully prepared.

PREPARING CONTAINERS, APPARATUS AND SOLUTIONS FOR TAKING AND CONSERVING THE BLOOD

Requisite cleanliness may be attained by many methods of treating the apparatus and vessels, but it is very important to remember that the sooner after a blood transfusion the apparatus is cleaned, the easier it is to clean it.

The vessels and apparatus must begin to be cleaned immediately after the end of the blood transfusion. After dismantling of the system each individual part should be washed with soap and water and the lumens of the glass tubes should be cleaned with a wire and cotton wrapped round its end; the rubber tubes should be kneaded with the fingers to remove blood clots from the lumens. After washing in warm running water and kneading, the tubes should be filled for two hours with a hot sodamide solution (1 per cent soda solution and 0.5 per cent ammonia), then washed in running water and boiled in the sodamide solution for 20 minutes, washed in running water and boiled in distilled water for 20 minutes, then sterilised in an autoclave for a period of 30 minutes at a temperature of 100°C.

The needles should also be washed with water, and an ammonia solution; their canals should be carefully cleaned with a mandrin and cotton and boiled in a 2 per cent sodium bicarbonate solution, then their lumens should be rinsed with alcohol or ether.

The washed parts of the apparatus should be sterilised in an autoclave or boiled in distilled water and kept wrapped up in sterile linen. Before use they are assembled and sterilised again.

The assembled and sterilised apparatus may be kept ready for use in sterile linens for 3-5 days.

The apparatus used for blood conservation is subjected to more complex treatment.

The vessels—glass jars and glass tubes—are rinsed with water, washed with a wire brush in a 1 per cent soda solution or a 0.5 per cent ammonia water solution, the solution being changed three times. Fifty ml of a 10 per cent potassium bichromate solution in sulfuric acid is poured into the jar and the latter is rinsed inside. One hour later the remnants of this solution are poured out and the jar is washed ten times with running water and twice with distilled water.

Another method: the jars are rinsed, filled with 0.5 per cent warm ammonia water solution for 24 hours, are cleaned with a wire brush, are immersed in a 0.5 per cent ammonia water solution, 2 per cent soda solution and 3 per cent soap solution, and are boiled in it for 15-20 minutes. After rinsing 2-3 times in hot, 6-8 times in cold and 2-3 times in distilled water the jars are placed upside down on clean linen.

New rubber tubes are placed in hot water for one hour, their lumens are brushed with a long wire brush to remove the talc, are washed with a stream of water and soaked for 6-24 hours.

Used rubber tubes are washed in running water, soaked for five hours and washed again; during the last washing they are kneaded on a hard surface to remove blood clots.

New needles should be cleaned to remove the vaseline with which instruments are usually coated. The lumens are cleaned with cotton, the needles are dried and kept in a 2 per cent paraffin solution in ether. Before use the needles should be cleaned and boiled in distilled water.

Standard Jars. Standard jars are assembled so that they form an enclosed system. A standard jar is a jar plugged with a rubber plug through which two glass tubes are passed. The long glass tube is connected by a rubber tube 45 cm long with a cannula and needle. The short glass tube is connected by a rubber tube (8 cm long) with a glass tube (5-6 cm long) which contains a cotton filter.

A ground-in stopper wrapped in paper and a glass tube for the needle are fastened to the neck of the jar.

The whole system is sterilised in a cloth bag.

Ampule for Blood Transfusion of the Central Institute of Blood Transfusion (CIBT). The ampule is a cylinder whose ends gradually change to thin glass tubes. The lower tube projects not only to the exterior but also into the interior in the form of an olive with holes; the olive serves as a filter.

A system of two rubber tubes, each 30 cm long is fitted on the upper tube; the rubber tubes connected with a glass tube end in nozzles. The system is used for taking blood (Fig. 116).

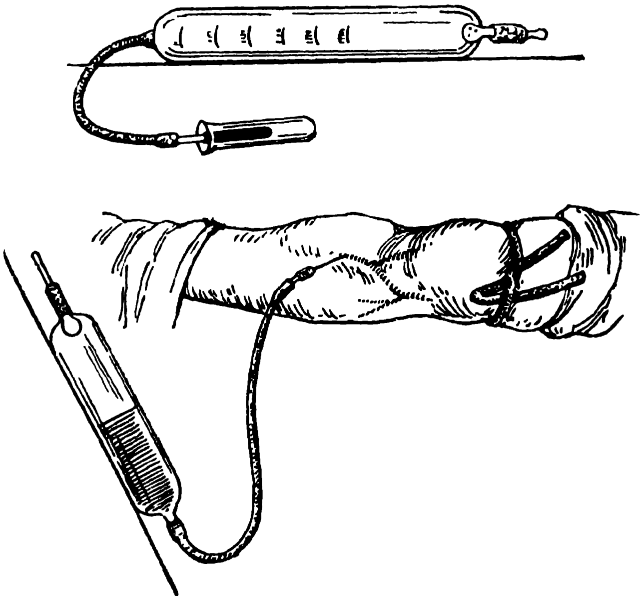


Fig. 116. Assembled ampule

A rubber tube 10 cm long and ending in a 5-6-cm-long glass tube which contains a piece of cotton (air filter) is fitted on the lower tube of the ampule.

A rubber tube (cap) a little longer than the tube with the glass stopper is made to shut the upper tube.

Preparing the Solutions. Proper preparation of solutions used for conserving blood is enormously important. The solutions are prepared with freshly distilled water, no more than six hours old and checked for sterility. Considerable attention is devoted to the cleanliness of the distilling apparatus.

After preparation the solution is filtered through a paper or cotton-gauze filter until it is absolutely transparent, following which it is boiled for 2-3 minutes and poured into assembled sterile vessels.

Stabilising Solutions. The following stabilising solutions are most frequently used:

1. Citrate solution (0.5 sodium citrate, 0.85 sodium chloride and 100.0 distilled water), 100.0 of the solution being used for 100 ml of blood; may be stored for up to twelve days.

2. Five or six per cent citrate solution (5.0 sodium citrate and 100.0 distilled water), 10.0 of the solution being used for 100 ml of blood; may be stored for up to 15 days.

3. Glucose citrate solution (5.0 sodium citrate, 100.0 distilled water and 10.0 of 25 per cent glucose); 10.0 of the citrate solution and 1.0 of the glucose solution are used for 100 ml of blood; may be stored for up to 25 days.

Citrate solutions with an addition of 1.0 sodium-sulfathiazole per 100.0 of the solution are also used.

4. Saccharose-glucose-citrate conserving solution (recipe No. 9 of the CIBT): 7.0 acid sodium citrate, 80.0 saccharose, 12.0 glucose, 2.0 sodium sulfacyl, 0.012 rivanol and 1000.0 bidistilled water; permits storing of blood for up to 45 days.

Sterilising the Apparatus. The apparatus used for conserving blood is sterilised assembled and containing the stabilising citrate solutions for one hour in an autoclave under a pressure of 1.5 atm; glucose solutions are sterilised in an autoclave separately for a period of 30 minutes.

The apparatus is sterilised on the day when the solution was poured into it and may be stored for no more than 24-48 hours.

The sterilisation is controlled daily by chemical tests and once a month by a bacteriological test, and is recorded in a special journal kept in the autoclave room according to the following form:

Date (day and month)	Material sterilised	Time sterilisation began	Time sterilisation ended	Regime, pressure, temperature	Control	Received by (signature)

After sterilisation the apparatus is kept in bags in special lockers. The time of sterilisation is marked on labels. If the apparatus was not used for two days, it is washed again and the conserving solutions are poured out. The apparatus is removed from the bags only at the moment the blood is to be taken.

Documentation. To avoid all errors, the intermediate medical personnel must keep accurate records.

The donor's documents (permit for blood giving and passport) are examined in the operating room and a record is made in the conserved blood journal.

At the end of blood-taking a complete record is made in the same journal in the presence of the donor; the record includes the date the blood was taken, the ordinal number, the blood group, donor's name, amount of blood taken, stabiliser, and name of physician taking the blood. The column in the journal concerning dispensation of the blood is filled in when the blood is dispensed.

The same information is simultaneously recorded on the label which is pasted to the vessel containing the blood.

Confused labels or an incorrect record of the blood group may lead to grave complications.

To avoid errors donors of the same group are simultaneously admitted into the operating room or separate operating rooms are set apart for different blood groups.

To prevent mistakes, the records in the journal and on the label are examined several times; the number in the journal must correspond to that on the label. Donors are released only after ascertaining the correctness of the documentation.

The labels have identification coloured strips: the 0 (I) group has a white strip, the A (II) group—a blue strip, the B (III) group—a red strip and the AB (IV) group—a yellow strip.

The amount of the blood taken is marked on the certificate brought by the donor with reference to the number in the conserved blood journal.

In the medical establishment where the blood transfusion is administered the latter is recorded in the case history, the record consisting of the patient's blood group, the certificate of the transfused blood, method, tests and the patient's reaction; all this information is also recorded in the hospital's blood transfusion journal.

Asepsis During Blood-Taking. The blood for conservation is taken in the operating room with careful observance of the rules of asepsis because the blood is very sensitive to infection which may enter it from the air, the donor's arm, or the mouths and hands of the medical personnel.

To prevent the blood from becoming infected from the air, the operating room must be kept immaculately clean, for which purpose the room must be ventilated and the floor, walls and furniture must be given a moist cleaning. The entire personnel, as well as the donors, wear cloth stockings, caps and masks. The donors are admitted into the operating room only wearing special gowns.

The personnel works in sterile gowns. The donor's arm, from the wrist to the middle of the upper arm, is rubbed down with alcohol and painted with a 5 per cent iodine tincture.

After application of a tourniquet the arm is covered with sterile linen.

The physician taking the blood washes his hands as before an operation and dons sterile gloves rubbing them down with alcoho after each puncture.

The blood containers are removed from the bags only before taking the blood.

Taking the Blood. After application of the tourniquet (Fig. 117) for the purpose of producing venous congestion (the pulse on the radial artery must be well pronounced) a venipuncture is made without removing the needle from the nozzle (Fig. 118). As the blood enters the vessel, the person taking the blood must see to it that it flows in an even stream, otherwise formation of clots is possible. The vessel for the blood should be carefully shaken so that the blood may mix with the stabiliser evenly.

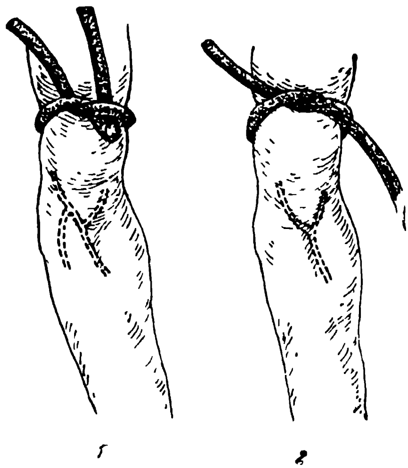


Fig. 117. Right way (*1*) and wrong way (*2*) of applying a tourniquet

Cessation of a good flow, the entrance of blood into the vessel by drops or arrest of the blood flow may be due to an excessively tightly applied tourniquet (the pulse in the radial artery is barely felt), too loosely applied tourniquet (veins below the tourniquet collapsed), incorrect position of the needle in the vein, puncture of both walls of the vein and formation of a hemorrhage.

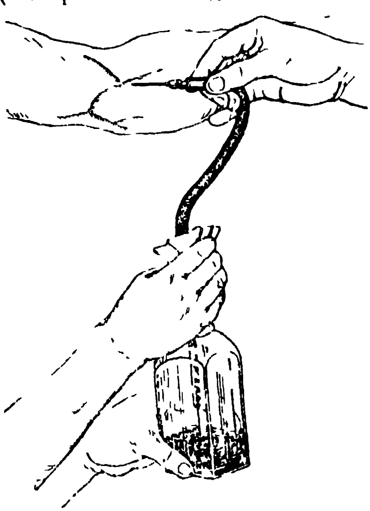


Fig. 118. Receiving system. Puncturing the vein without removing the needle from the nozzle

Attempts are made to produce a good flow of blood by correct application of the tourniquet and changing the position of the needle or making a new puncture. After blood-taking the point of the puncture is painted with a 5 per cent iodine tincture and is dressed.

After blood-taking the blood group is ascertained and the vessel is plugged. Standard jars are plugged with rubber plugs; the ampule tubes are covered with

rubber caps which are tied to them with a strong thread and are immersed in molten paraffin.

The container must be closed tightly enough not to permit even a drop of blood to soak through should the container be overturned.

The jar is plugged and a label showing the time the blood was taken, the blood group, character of conservation and the donor's name is pasted to it, following which the container is placed in a refrigerator (temperature—4°C above zero).

Conserving the Blood. When blood is being taken, it may rapidly coagulate as it leaves the donor's blood vessels. To prevent this, the cannula through which the blood is drawn and the container are either coated with paraffin or a sodium citrate solution is added to the blood.

If a 6 per cent sodium citrate solution amounting to 10 per cent of the blood volume is added to the blood, the latter may be preserved in a refrigerator. Such blood is called conserved blood and may be transported over long distances.

The stored blood must be tested (Wassermann's test for lues, and a general test). The blood of syphilitics, malaria and tuberculous patients is unfit for transfusion. Blood is usually kept in a refrigerator at a temperature of +4°C. During transportation the blood must not be shaken and must be protected against considerable temperature fluctuations (freezing, heating).

ROLE OF THE NURSE IN BLOOD TRANSFUSION

During blood transfusion the nurse plays an extremely important role. First of all she prepares all the apparatus and everything else necessary for taking the blood from the donor and sees to it that the containers are clean and sterile.

The nurse's duties include watching that the blood is properly preserved and is fit for use, ascertaining the reasons for its spoilage, keeping records of the blood and the blood transfusion journal, preparing everything that is necessary for transfusion (sterilisation of the needles and tubes), making requests for blood, keeping records of spoiled blood, etc.

Large hospitals employ special nurses for the blood transfusion rooms.

The nurse plays a still more important part at blood transfusion stations.

Donorship. Blood for transfusion is taken from a healthy person and is transfused to a patient (recipient). The person who gives blood for medical purposes (donor) must undergo a medical examination every two weeks; during the medical examinations his blood is tested (Wassermann's test and general test) to exclude lues, malaria and tuberculosis. Any healthy 20-40-year-old

person with good blood (at least 82 per cent hemoglobin in men and at least 75 per cent in women) may be a donor. In the U.S.S.R. donorship is an honourable service and many working people, including medical workers, willingly give their blood to patients who are in need of it.

The choice of donors is a very serious affair and two of the main aims of donorship must not be overlooked, namely, maximum benefit to the patient and no harm to the donor.

Blood may be taken an indefinite number of times provided its composition has returned to normal at the time it is to be taken. Blood should not be taken from donors running a fever or from women during menstruation, pregnancy and nursing. To enhance the regenerative processes of the hemopoietic system requires extra nutrition, and donors are therefore given pecuniary compensation. The blood is taken after the donor has had a light breakfast (sweet tea, 150 g of white bread and 25-30 g of butter).

While the blood is being taken the donor must be in a recumbent position. After the blood-taking the donor rests for thirty minutes in a recumbent position.

Techniques of transfusion. When conserved blood is used, blood of the corresponding group is taken from the refrigerator and its individual compatibility with the blood of the recipient is determined by mixing a drop of the blood taken for transfusion with a drop of the patient's serum.

Stored conserved blood should be examined daily to ascertain its fitness for transfusion.

Stored blood may suffer certain changes which render it unfit for transfusion (hemolysis, coagulation, infection).

In storage conserved blood divides into two layers: the blood cells settle to the bottom, while the upper layer consists of the fluid part—plasma—which is transparent, light-yellow and sometimes whitish.

Hemolysis is manifested as a pink ring between the erythrocytes and plasma; the ring increases during storage. Hemolysis indicates disintegration of the erythrocytes and frequently infection and unfitness of the blood for transfusion.

Blood coagulation which produces blood clots in the erythrocyte layer or the plasma renders the blood dangerous for transfusion. Small clots in the erythrocyte layer may be overlooked, while the clots in the plasma, on the surface or in the shape of columns running from the surface to the blood-cell layer are easier to see.

The third reason for unfitness—infection of the blood—is revealed by formation of residue and flakes in the plasma.

The following signs show that the blood is fit for transfusion: the blood plasma separated from the erythrocytes in storage

must be pink (hemolysis) and must not contain flakes or films; the blood must have no clots.

Before the blood is used its fitness must be ascertained, i.e., it must be examined for hemolysis and infection.' The plasma over the precipitated erythrocytes must be transparent, amber-coloured, without clots, flakes or films (a pink cloud appears during hemolysis). An even turbidity of the plasma due to the presence of minutest droplets of fat in it ("satiated blood") is no obstacle to its transfusion. Hemolysis is determined more

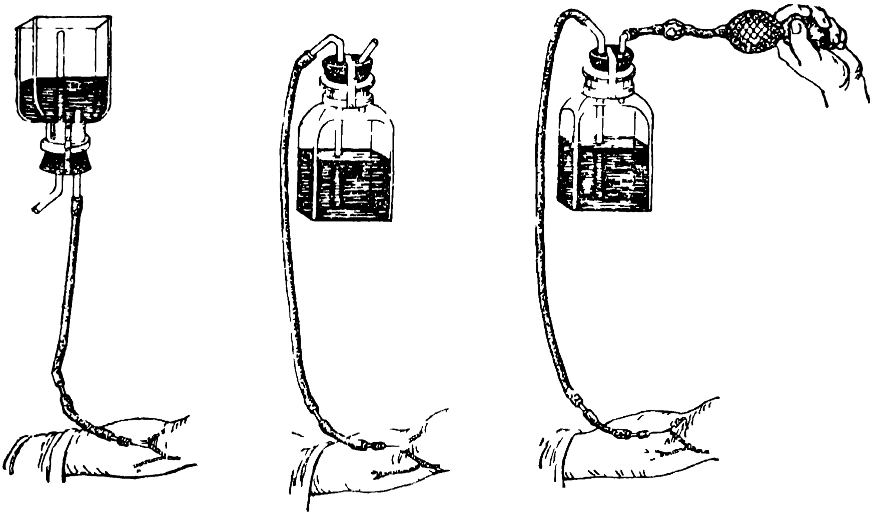


Fig. 119. Transfusion from a standard jar

accurately by centrifuging the blood in a test tube. Pink coloration of the plasma confirms hemolysis. If the blood has but a small number of clots, it is also considered fit for careful transfusion.

The blood is first heated to room temperature and is then placed in a vessel with warm water to which warm water is constantly added so that its temperature may not exceed 38-39°C. Transfusion of unheated blood is now permissible. The jar is plugged with a rubber plug through which two glass tubes—a long one, almost reaching the bottom of the vessel, and a short one—are passed. A rubber tube with a cannula is fitted on the short tube. The rubber tube is closed with a clamp. The plug is tied fast to the neck of the jar. The plug and all tubes must be sterile.

The jar taken out of the water is dried and turned upside down (Fig. 119), the clamp is taken off to remove the air and fill the system with blood, following which the rubber tube is clamped again and with a needle prepared beforehand is handed to the physician who is making the transfusion. An improperly assembled jar (short tube above the blood level) may produce fatal complications (emboli). The technique of transfusion is the same as in intravenous injection of physiologic saline solution, only the needle must be thicker and be connected with the tube through a cannula.

Before transfusion the nurse covers a small table with a sterile sheet and sets on it all that is necessary in a sterile pan—the system of tubes for transfusion, needles for transfusion, syringe and needles for anesthesia, sterile towel to demarcate the operative field, and sterile dressing material.

If the blood is prepared in ampules (Fig. 120), the rubber cap is removed from the lower end of the ampule where there is the filter, the glass nipple of the ampule is wiped with alcohol and is connected with the sterile rubber tube and nozzle leading to the needle.

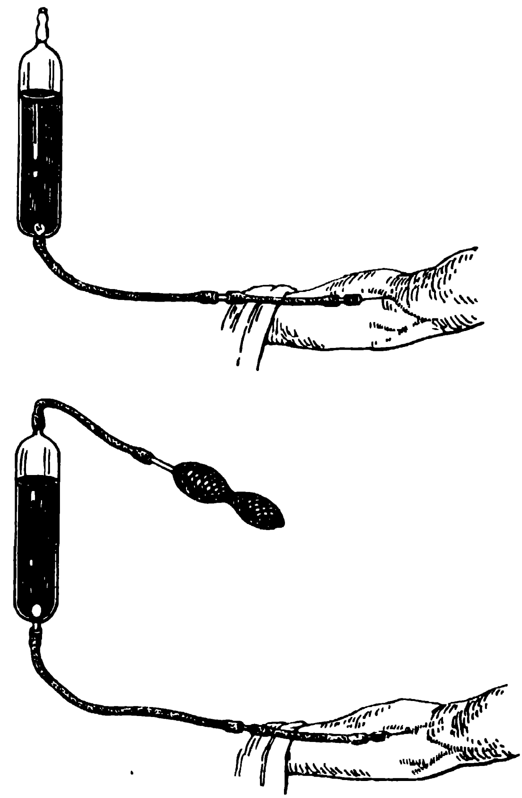


Fig. 120. Blood transfusion by means of an ampule

The upper rubber cap of the ampule is cut off and the blood begins to run through the rubber tube to the nozzle. The nozzle is raised to displace the air from the tube and is slowly lowered to fill the entire system of tubes with blood; the moment a stream of blood appears the clamp is transferred from the nozzle to the tube and the nozzle is connected with the needle.

Unlike the standard jar, the neck of the bottle can be tightly plugged with a rubber plug which, during blood transfusion, is

wiped with alcohol and punctured with a special needle connected with the system of tubes ending in a needle which is introduced into the recipient's vein. When the second (long) needle is introduced through the plug and the bottle is raised the blood will run by gravity into the recipient's vein.

Drip method of blood transfusion. The drip method of transfusing blood, physiologic saline solution and other fluids has gained currency in recent years. The nurse is required to have good knowl-

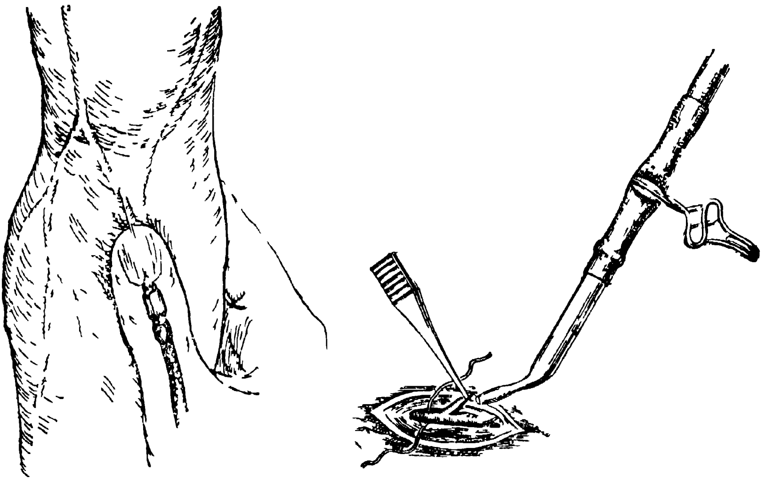


Fig. 121. Venipuncture (*a*) and venesection (*b*)

edge of this method of transfusion and to watch the transfusion carefully in order to prevent possible complications.

The blood is infused by means of a venipuncture (Fig. 121, *a*) or venesection (Fig. 121, *b*) most frequently into the veins of the forearm, shank and foot.

A dropper which makes it possible to keep count of the number of drops infused per minute must be attached to the transfusion system. The dropper is not completely filled, some air being left in its upper part (Fig. 122). To decrease the flow of blood, the tube above the dropper is compressed with a special screw clamp or Péan's forceps. After setting the clamp to pass 20-60 drops per minute the person making the transfusion watches carefully to see if the blood enters the patient's vein.

The jar or bottle with blood is suspended from a special stand.

The method of drip transfusion is used when it is necessary to infuse the blood and liquids slowly and in large amounts.

To prevent complications, the drip method is usually used for no more than 24 hours during which time two or three litres of solution is infused.

CARE OF THE PATIENT AFTER BLOOD TRANSFUSION

After transfusion the patient is brought to the ward on a wheeled stretcher, following which he must remain in a recumbent position in bed for at least 2-3 hours. The patient's general condition, appearance, pulse, temperature and micturition are carefully watched. In case of chills the patient is made warm by wrapping and hot water bottles, and, if necessary, is given cardiacs. It is best not to feed the patient for one or two hours after transfusion because of possible vomiting. The patient's blood and urine are tested the following day.

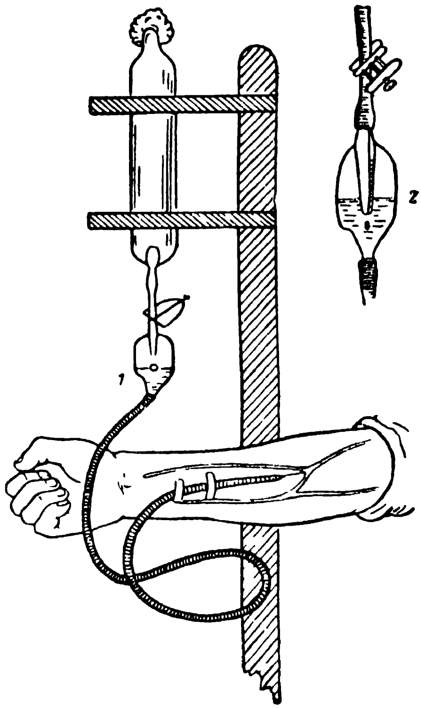


Fig. 122. Blood transfusion by the drip method. Setting the blood level in the dropper—right way (*1*) and wrong way (*2*)

Liquid blood substitutes. During shock, hemorrhages, intoxication, as well as in a number of other cases, especially when the organism has been dehydrated and the blood has thickened, liquid blood substitutes are widely used. These include blood plasma and serum.

Native plasma is the upper layer of stabilised blood without the blood cells.

Blood serum is the fluid part of coagulated or defibrinated blood from which the blood cells and fibrin have been removed.

The plasma and serum contain proteins (especially the plasma), antibodies and hormones, and can therefore partly replace the lost blood; they also aid in arresting hemorrhages.

The plasma and serum may be conserved in a liquid state or dried, and may be stored for many months.

Ampules containing a residue, films (suspected infection), gases and packing defects make the liquid plasma and serum unfit for use.

To transfuse dry plasma and serum, the latter are dissolved in sterile distilled water, the amount of liquid used either equal-

ling that prior to the drying (indicated on the ampule) or 25-30 per cent (concentrated plasma and serum).

Dry plasma and serum may be stored for a long time, whereas dissolved they must be used immediately.

Protein hydrolysates containing mixtures of amino acids:

1. Hydrolysin (hydrolysinum L-103) is administered subcutaneously, intramuscularly and intravenously in doses of 250-500 ml in solution dispensed in hermetically sealed bottles. It is stored at a temperature of 4-6°C.

2. CIBT protein hydrolysate is administered subcutaneously and intravenously from 250-ml ampules at the rate of 60-90 drops per minute. Administration of up to two litres of the solution is permissible.

3. Aminopeptide (aminopeptidum) is dispensed in 250-ml ampules and is administered subcutaneously, intramuscularly and intravenously at the rate of 10-20 to 50-60 drops per minute, a total of up to 1-2 litres a day.

Saline blood substitute solutions are widely used in surgery. The most important of these are:

1. Saline solution containing 7.5-9.0 of sodium chloride per one litre of solution.

2. CIBT saline infusin (8.0 of sodium chloride, 0.2 of potassium chloride, 0.25 of calcium chloride, 0.05 of magnesium sulfate, 0.138 of sodium phosphate and 0.8 per cent of sodium bicarbonate per one litre of solution).

3. CIBT transfusin (7.5 of sodium chloride, 0.4 of potassium chloride, 0.1 of magnesium chloride, 0.208 monobasic sodium phosphate, 0.119 dibasic sodium phosphate, and 10.0 of glucose per one litre of solution).

4. CIBT serotransfusin (CIBT transfusin plus 20 per cent serum).

5. Asratyan's liquid (20.0 of glucose, 15.0 of sodium chloride, 2.5 of calcium chloride, 1.2 of sodium bromide, 1.0 of sodium bicarbonate, hypnotic [dose depending on the type of preparation] and 40.0 of alcohol per one litre of solution).

6. Polyglucin. A solution of a high molecular compound, glucose polymer. It is a valuable substitute, especially during shock and is administered by the drip method in doses of 200-1,000 ml. After administration of the first 25 ml an intermission of 2-5 minutes is made. In the absence of reaction the infusion is continued. It is contraindicated in cranial injuries, nephrosonephritis and cardiac decompensation. It is stored at room temperature.

Transporting the blood. The blood is shaken up the least during transportation by rail and air. Transportation by automobile and cart is less favourable.

Good packing before transportation is very important. Each ampule, jar or bottle should be wrapped in cotton or felt.

During the warm and cold seasons blood should be transported in special isothermic boxes at a temperature of 4-8°C.

Blood may also be transported in ordinary wooden boxes lined with felt and covered with a tight-fitting lid; each ampule or jar wrapped in cotton should be placed in the box vertically. The box should be wrapped in a blanket. Over short distances blood may also be transported in cotton-padded bags. Transportation is best endured by fresh blood (1-3 days old).

DESMURGY

CONCEPT OF BANDAGES

Bandages perform the following functions: 1) *They hold dressings in place* (*usual bandages*); 2) *apply constant pressure on a certain area* (*pressure bandages*); 3) *immobilise a part* (*fixed bandages*); 4) *provide traction*, and 5) *correct the position of a part* (*corrective bandages*).

The teaching on bandages, their proper use and application is called *desmurgy*.

Bandages may be divided into two groups—soft and hard—according to the material used. The first group includes plaster, adhesive, triangular, loop and roller bandage; the latter group includes splint, starch and plaster of Paris bandages.

TRIANGULAR BANDAGES

A triangular bandage is made of a quadrangular piece of cloth or kerchief folded so that a triangle results (Fig. 123). Its longest side (*C*) is called the base, the corner (*A*) opposite this side is the apex, while the other two corners (*B* and B^1) are the ends. This bandage is used under hospital conditions and most frequently serves as a *sling* (Fig. 123, *a*), i.e., to support the arm in a number of purulent diseases and injuries of the hand, forearm and upper arm, fractures of the clavicle, etc. The middle of the bandage (Fig. 123, *a*) is placed under the forearm flexed at a right angle, the base (*C*) running along the middle line of the body and the apex (*A*) directed towards the elbow between the body and the arm; the ends are tied around the neck (the *B* end running between the forearm and the body usually goes over the injured shoulder and the B^1 end running anterior to the forearm over the intact shoulder). The apex (*A*) is drawn around the elbow back to front, is straightened out and pinned to the front part of the bandage.

A wide roller bandage may be used instead of the triangular bandage to suspend the arm. Any, even small, piece of cloth or kerchief may be used for the dressing; even the skirt of the jacket may be rolled under the arm and pinned.

In administering first aid a triangular bandage may be made of any kerchief by folding the latter corner to corner and applying it to any part of the body (Figs. 123, *a*, 123, *b*, 123, *c*, and 123, *d*).

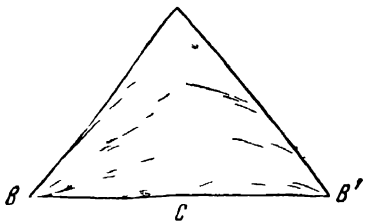


Fig. 123. Triangular bandage

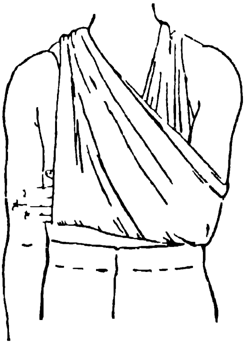


Fig. 123, *a*. Sling

Fig. 123, *b*. Spiral bandage for hand

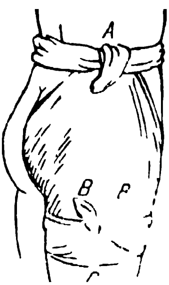


Fig. 123, *c*. Triangular bandage for one buttock

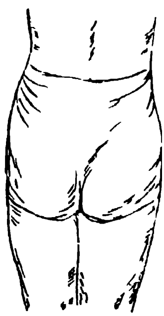


Fig. 123, *d*. Triangular bandage for both buttocks

FOUR-TAILED BANDAGE

A four-tailed bandage is a piece of cloth or roller bandage with longitudinal cuts at both ends. It is convenient for small dressings on the face and is indispensable for dressings applied to the nose.

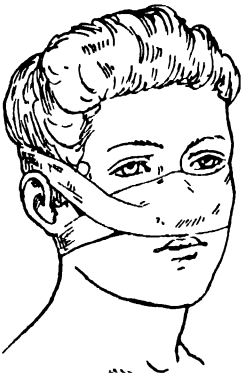


Fig. 124. Four-tailed bandage for nose

The four-tailed bandage is applied to the nose as follows (Fig. 124): the uncut part is placed across the face to cover the nose; in the area of the zygomatic arches the tails of the bandage are crossed, the lower ends raised above the ears and the upper ends dropped below the ears, the former being tied on the occiput and the latter on the neck.

When a four-tailed bandage is applied to the chin, the chin is covered with the uncut parts and the tails are crossed; the lower tails are raised and tied on top of the head; the upper tails are drawn around the head in the region of the occiput, are crossed and tied on the forehead. If the four-tailed bandage is applied to the region of the occiput, the lower tails are tied on the forehead and the upper tails under the chin. This bandage is similarly applied to the top of the head and forehead, the tails being tied on the occiput and under the lower jaw.

T-SHAPED BANDAGE

A T-shaped bandage consists of a strip of cloth (or roller bandage) to the middle of which the end of another strip is fastened, or of a strip over the middle of which another strip is passed (Fig. 125). A T-shaped bandage is very convenient for the perineum; the horizontal part engirds the waist and the vertical strips run from the belt over the perineum and are fastened at the belt on the other side of the body (Fig. 126).

ROLLER BANDAGE

Roller bandages are the most convenient; they hold best and exert the most uniform pressure. A roller bandage (Fig. 127) is a piece of cloth shaped like a ribbon 5-10 cm wide and about 5-7 m long. A 5-cm wide bandage is usually used for bandaging the fingers, a 7-9-cm wide bandage is used for the head, forearm, upper arm and shank; a bandage 9-18 cm wide is used for the thighs and body.

Roller bandages made of dense cloth are scarcely used any more; today they are usually made of gauze (soft) which stretches and very easily assumes the shape of the bandaged part. Gauze does not prevent evaporation and is cheaper. Roller bandages are rolled like spools. The remaining free end (*B*) is called the beginning and the rolled part (*A*)—the head of the roller bandage.

To prepare a roller bandage, gauze is ripped or cut into longitudinal strips. The former method is inconvenient because, when ripped into strips, the gauze wrinkles and "crumbles". It is best to roll a piece of gauze, along its entire width, on a thin iron rod, and after removing the rod to cut the gauze into separate rolls. The roller bandage is rolled by a machine or by hand; its end is folded double, quadruple, etc., to produce a compact little roll around which the roller bandage is rolled as though on a spool (Fig. 128). Ready-made factory-produced roller bandages are most frequently used.

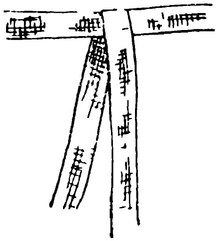


Fig. 125. T-shaped bandage

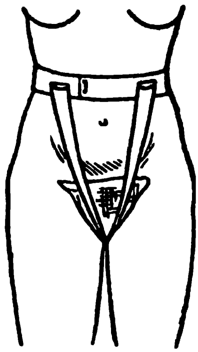


Fig. 126. T-shaped bandage for perineum

For convenience in bandaging and for proper application of the dressing certain rules must be observed. While the dressing

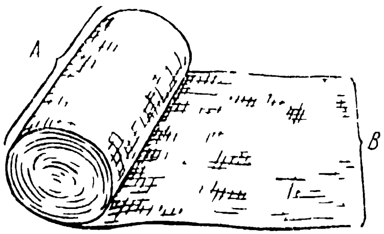


Fig. 127. Roller bandage

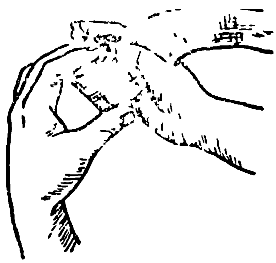


Fig. 128. Rolling a bandage

is being made, the patient must be in a comfortable position or else he will unwittingly change his position, which will affect the bandaging. The part being bandaged must be absolutely immobile because any movement of the patient will displace the spirals of the bandage and will interfere with its proper ap-

plication. Of course, the part being bandaged should be completely accessible to the bandager.

The part being bandaged (this applies particularly to the limbs) must be imparted the position in which it will function best after

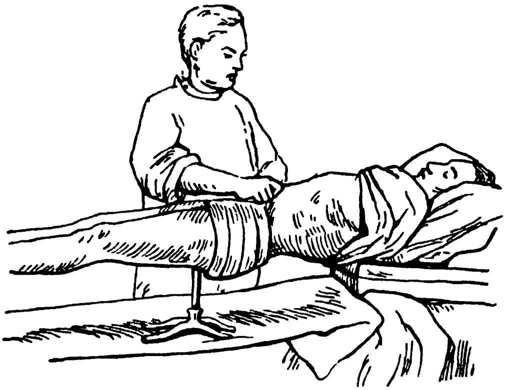


Fig. 129. Bandaging with the patient resting on a pelvic support

the bandaging. For example, a bandage applied to a flexed knee will prove useless if the patient will walk and extend the leg; a bandage applied to the elbow of an extended arm will be uncomfortable if the patient's arm has to be carried in a sling.

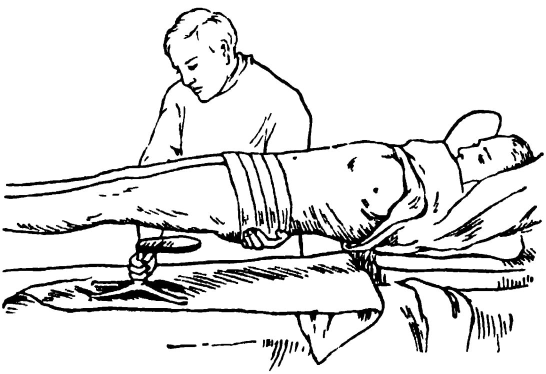


Fig. 130. Removing the support

Taking this into consideration, the fingers during bandaging must be placed in a slightly flexed position, the thumb and little finger opposing each other and the arm flexed at a right angle. The region of the shoulder must be bandaged with the arm slight-

ly abducted from the body. The lower extremities in the region of the hip and knee joints must be bandaged with the leg extended and the foot flexed at a right angle.

To impart a certain position to an extremity, someone is asked to hold the injured parts, or else supports or bolsters are placed under them, for example, under the shoulder blades when bandaging the chest, under the pelvis when bandaging the abdomen and hip joint (Figs. 129 and 130), etc. It is very desirable that the part being bandaged should be on the level of the upper part of the bandager's chest and that he should not have to bend very much or raise his arm high. For convenience of bandaging and easy approach to the patient from all sides, special tables which do not need any supports are used.

The bandager usually faces the patient to see by the expression of the latter's face whether or not the bandaging hurts. Bandaging, especially of the limbs, is begun at the bottom and conducted upward, the right hand unrolling the head of the bandage and the left—holding the dressing and straightening out the rolls of the bandage. Usually a typical bandage (see below) is used as a basis and is modified according to need, otherwise the dressing requires too many bandages and a poor dressing is the result. The roller bandage is unrolled in one direction, most frequently from left to right (with respect to the bandager), i.e., clockwise; each turn of the bandage must cover half or two thirds of the width of the preceding turn. The head of the roller bandage must not be far removed from the part being bandaged. In a properly applied bandage each layer of the roller bandage covers two thirds of the width of the preceding layer tightly and without creases.

After bandaging it is necessary to examine the bandage to see if it covers the injured part properly, fits tight and is in place. Whether the bandage is too tight and exerts too much pressure on the part is determined by the patient's sensations.

The terminal part of the bandage is usually fastened on the side opposite to the wound, where the knot will not discomfort the patient. The end of the bandage ripped longitudinally is tied around the bandaged part. The bandage rips easily if the ripping is started 4-5 cm from the end. The end of the bandage may be stitched or pinned with a safety pin to the dressing, or, by slightly tearing the bandage, it may be fastened to one of the neighbouring turns running in the opposite direction.

TYPES OF ROLLER BANDAGES

A *circular bandage* is the simplest; one end of the bandage is applied to the part being bandaged, this end being held in place with the left hand and the bandage being unrolled with the right hand, its turns covering each other completely. To make the band-

age stronger, its end may be at first left uncovered (Fig. 131) then folded over the second turn and fastened by a circular turn (Fig. 132). Such bandages are made for injuries to the wrist, lower part of the shank and forehead.

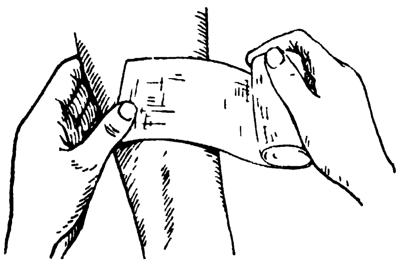


Fig. 131. Beginning a circular bandage

A *spiral bandage* is begun like a circular one, but after two or three circular turns the bandage is applied obliquely (spirally) only partly (two thirds) covering the preceding turns. It is applied from the bottom upward (ascending) or from the top downward (descending). In this form the bandage fits well only when the bandaged part is of equal girth throughout, for example, the upper arm and sometimes the thigh; however, if the part is not of equal girth (shank, forearm), for better fit the bandage must be applied with reverse folds. When a reverse fold is made (Fig. 133), the bandage is directed obliquely, the left thumb holding its lower edge, the head of the bandage being slightly unrolled and the bandage reversed to-

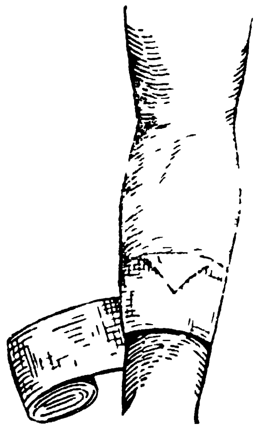


Fig. 132. First turn of a circular bandage

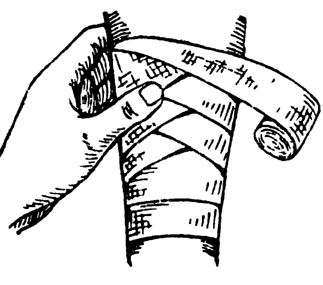


Fig. 133. Spiral reverse bandage

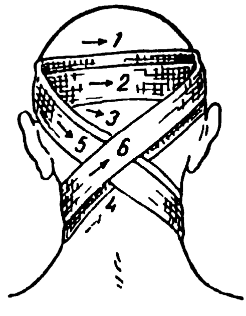


Fig. 134. Figure-of-eight bandage

wards the bandager, its upper edge becoming the lower and its lower edge becoming the upper edge. The more uneven the girth of the part being bandaged, the sharper the reverse fold. Subsequently the bandage is continued either spirally again

or with new reverse folds, according to need. All the reverse folds must be made on one side and in one line.

A *creeping bandage* resembles the preceding one; it begins like a circular bandage and then proceeds screw-like so that none of its turns come in contact with each other. Such a bandage is applied only in the beginning of bandaging for temporarily holding the dressing in place and is continued as a usual spiral bandage which is much stronger

Cross-shaped or figure-of-eight bandage is so called because of its shape or the turns of the bandage which resemble a figure of eight; it is very convenient for bandaging parts with an irregular surface. It is applied to the occiput and back of the neck

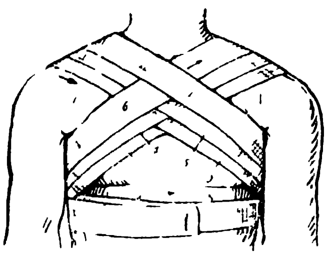


Fig. 135. Spica bandage for chest

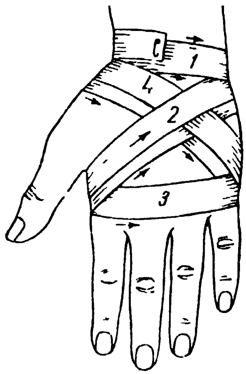


Fig. 136. Spica bandage for hand

as follows (Fig. 134): with circular turns (*1* and *2*) the bandage is fastened around the head, the turns being made in the direction indicated by the arrow, then higher and behind the left ear it is obliquely brought down to the neck (*3*), following which it is carried along the right lateral surface of the neck, brought to the front and raised along the dorsal side of the neck to the head in the direction of the arrow (*4*). After a turn in front of the head the bandage is carried over the left ear and obliquely, repeating the third turn (see fifth turn), then around the neck and obliquely upward to the head, repeating the fourth turn (see the sixth turn). The bandaging is continued by alternating the two last turns and the bandage is fastened around the head.

A figure-of-eight bandage on the chest (Fig. 135) is begun with a circular turn which fastens the bandage around the thorax, then the bandage is carried along the anterior surface of the chest upward and obliquely from the right side to the left shoulder. Across the back the bandage runs over the right shoulder and

obliquely down under the left axilla, then again across the back to the right axilla and thence over the left shoulder. It is fastened around the chest.

To the back of the hand the figure-of-eight bandage is applied (Fig. 136) beginning with a circular turn immediately above the wrist, after which the bandage is carried obliquely across the back of the hand to the palm where a circular turn is made and raised obliquely along the hand, crossing the second turn. Subsequently the turns alternate and the bandage is fastened on the wrist.

If the turns in a figure-of-eight bandage do not completely cover the preceding turns at the points of crossing but, when crossing in one line, run below or above the preceding turns the point of crossing resembles a spike. In this case it is a *spica bandage*. It is applied to the shoulder as follows (Fig. 137): the

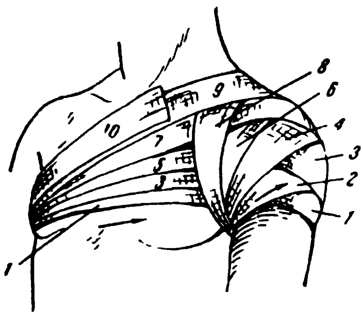


Fig. 137. Spica bandage

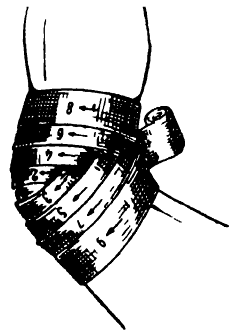


Fig. 138. Turtle bandage

bandage is carried from the healthy axilla across the front of the chest (*1*) and over the shoulder in the direction of the arrow. After a turn around the anterior, lateral and posterior surface of the shoulder the bandage is carried to the middle of the shoulder and from the axillary region raised obliquely along the shoulder in the direction of the arrow (second turn), across the preceding turn along the lateral surface of the shoulder to the back and across the back to the healthy armpit. Then the first turn is repeated (this is the third turn) somewhat higher and is followed by a repetition of the second turn (this is the fourth turn), etc.

Converging and diverging or so-called *turtle bandage* is very convenient for joints (elbow, knee, etc.) in a flexed position. In the region of the knee a diverging bandage (Fig. 138) is begun with a circular turn over the most protruding part of the patella, after which similar turns are made below (*2*) and above (*3*) the preceding turn. The turns cross in the popliteal space and diverging in both directions from the first turn increasingly cover

the region of the joint (4th and 5th, 6th and 7th, 8th and 9th turns). The bandage is fastened around the thigh. The converging bandage is begun with the eighth or ninth turns, i.e., circular turns

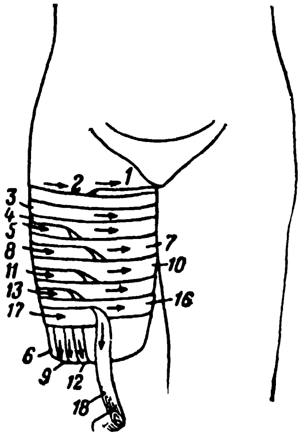


Fig. 139. Recurrent bandage for stump

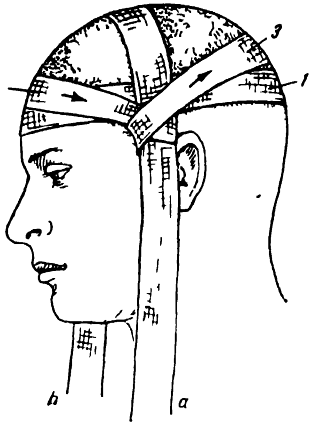


Fig. 140. Recurrent bandage for head injury (beginning)

above and below the joint and crossing in the popliteal space. The subsequent turns are similar to the preceding ones and ap-

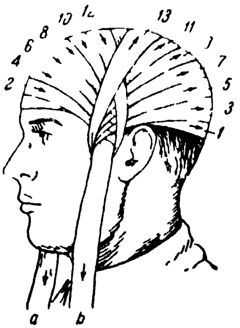


Fig. 141. Recurrent bandage for head injury (finished)

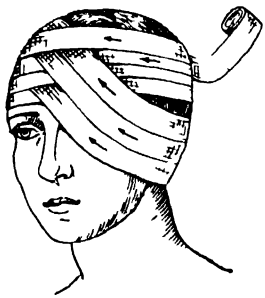


Fig. 142. Recurrent bandage for one eye

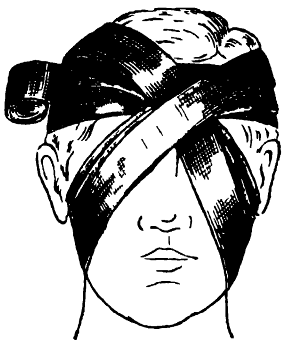


Fig. 143. Recurrent bandage for both eyes

proach each other at the most protruding part of the joint until the entire region is covered.

A *recurrent bandage* is convenient for round surfaces, for example, on the skull or amputation stump. Fig. 139 shows application of this bandage to an amputation stump. With a few cir-

cular turns (1st, 2nd, 3rd and 4th) the bandage is fastened transversely round the thigh, after which a reverse fold (*5*) is made on the anterior surface and the bandage is carried longitudinally along the thigh like the free end of the roll shown in the figure (*18*), brought around the amputation stump (*6*) to the posterior surface and carried upward along the stump. A little below the first reverse fold another fold is made and the bandage is carried circularly (*7*) to fasten the longitudinal strip of the bandage. Subsequently the transverse turns of the bandage alternate with the longitudinal turns, the longitudinal turns gradually covering the entire amputation stump and the transverse turns serving to fasten them.

We have already described the main types of bandages. Now we shall describe the most frequently used bandages.

Head Bandages. Four-tailed bandages may be applied to the head for minor injuries; triangular bandages are also sometimes used.

Recurrent bandage. This bandage fastened by a strip of gauze to the lower jaw (Fig. 140) is very convenient. A strip of gauze, a little less than one metre long is placed on top of the head, both its ends *a* and *b* hanging down vertically in front of the ears where the patient himself or an assistant holds them taut. The first turn is made around the head; after reaching the strip of gauze the bandage is carried around it and somewhat obliquely, covering the occiput. On the other side the bandage is similarly drawn around the vertical strip of gauze and carried obliquely, covering the forehead and part of the top of the head. Thus the bandage is carried evermore obliquely over the vertical strip of gauze until the head is completely covered, after which the bandage is either fastened with a circular turn or to the vertical strip of gauze, and the ends *a* and *b* are tied under the chin, which firmly keeps the whole bandage in place (Fig. 141).

A *one-eye bandage* varies with the eye (right or left) that has to be covered. In bandaging the right eye the roller bandage is held as usual and carried, as always, from left to right (with respect to the bandager). In bandaging the left eye (Fig. 142) it is more convenient to hold the head of the bandage in the left hand and to bandage from right to left. The bandage is fastened with a circular horizontal turn, carried downward on to the occiput, under the ear on the affected side obliquely across the cheek and upward, covering the affected eye. The oblique turn is fastened with a circular turn after which another oblique turn is made somewhat higher than the preceding one; the eye is covered by alternate circular and oblique turns.

Bandage for both eyes. (Fig. 143). The bandage is held as usual, fastened with a circular turn, then carried downward across the top of the head and forehead, and an oblique turn downward covering the left eye is made; the bandage is carried around the

occiput and another oblique turn upward, covering the right eye, is made. Thus all the subsequent turns cross in the area of the bridge of the nose, and descending lower and lower cover both eyes. The bandage is fastened with a circular horizontal turn.

Bridle. Head bandages in the form of a bridle are very convenient. The simplest of these bandages begins with a horizontal turn (Fig. 144). The bandage is carried obliquely in the occipital region to the lateral surface of the neck, thence under the jaw vertically in front of the ears. The necessary number of vertical turns with which the entire top of the head and occiput may be covered is made, following which the bandage is carried from under the chin obliquely to the occiput on the other side of the neck,

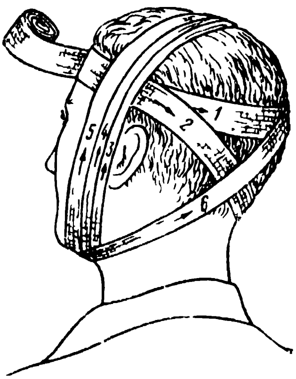


Fig. 144. Bridle bandage

Fig. 145. Bridle bandage for chin

and the bandage is fastened with a horizontal turn. The same bandage may serve to cover the lower jaw. After the bandage is fastened round the head the roll is carried obliquely downward in the region of the occiput (Fig. 145), several horizontal turns are made on the neck round the chin, following which vertical turns are made and the bandage is fastened, like the preceding one round the head.

The figure-of-eight bandage for the occiput has already been described.

Neck bandages. Some of the most difficult bandages are those for the neck because they easily come off. A neck bandage must be light and thin; circular turns which are unpleasant for the patient and interfere with respiration should, if possible, be avoided. In bandaging the upper part of the neck several oblique turns around the top of the head towards the occiput, alternating with circular turns, or a figure-of-eight bandage for the occiput, its turns alternating with circular turns, are made. In bandaging

the lower part of the neck or the whole neck the circular turns are supplemented with turns of the figure-of-eight bandage for the occiput and figure-of-eight bandage for the back running across the axillary region (Fig. 146).

Upper-Limb Bandages. A *bandage for fingers* (Fig. 147) begins with circular turns on the wrist (*1*) and is carried obliquely across the back of the hand (*2*) to the end of the affected finger, the whole finger being bandaged with spiral turns (*3*, *4*, *5*, *6* and *7*),

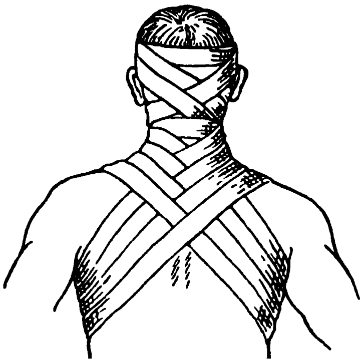


Fig. 146. Fastening a neck bandage to the thorax

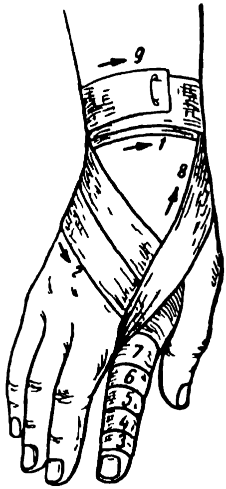


Fig. 147. Spiral bandage for a finger

after which the bandage is carried across the back of the hand (*8*) to the wrist where it is fastened. If the tip of the finger has to be covered, a recurrent bandage is made. At first the bandage is placed on the anterior aspect of the finger, then it is carried over the tip to the posterior aspect and up to the base and then again along the finger, covering its lateral surface, after which the finger is bandaged spirally, as shown in the preceding bandage (Fig. 148).

Finally, the recurrent bandage may be fastened on the wrist, if the bandage is carried over the tip of the finger to the palmar surface, and after it is fastened on the wrist a third, fourth, fifth and sixth turns are made, i.e., the bandage is carried to the tip of the finger and is wound spirally round the whole finger. The bandage is fastened near the wrist.

The same bandage may similarly be made for several fingers, each finger being bandaged separately, in which case the bandage will look like a glove. The bandage begins on the little finger on the left hand and the thumb on the right hand. The

bandage for the thumb is a spica bandage (Fig. 149). It is fastened on the wrist (*1*) with a circular turn, is carried across the back of the hand to the tip of the finger (*2*), thence winding spirally around the finger (*3*) to the posterior and then the anterior surface of the wrist, thence again to the tip of the finger, etc., gradually rising to the base of the finger and making all turns like the sixth and seventh turns. When completed the bandage is fastened on the wrist.

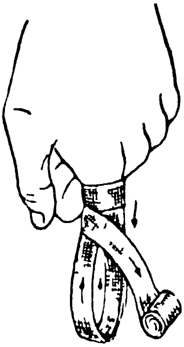


Fig. 148. Recurrent bandage for a finger

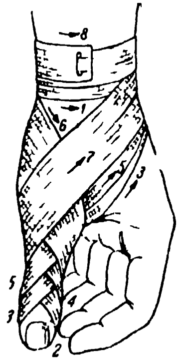


Fig. 149. Bandage for the thumb

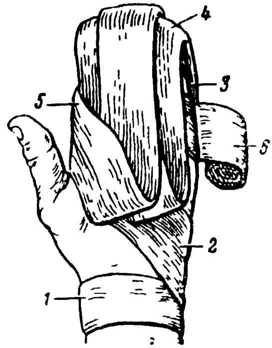


Fig. 150. Recurrent bandage for the hand

Bandage for the hand. The hand is usually bandaged with a figure-of-eight bandage. Together with four fingers the hand is bandaged with a recurrent bandage (Fig. 150).

Bandage for the forearm and elbow. The forearm is bandaged with a reverse spiral bandage (see Fig. 134), like an extended elbow. For a flexed elbow (injury to the elbow joint) a turtle-type, converging or diverging bandage, like the one described for the knee, is made.

A *bandage for the whole arm* begins in the shape of a glove for the fingers and is continued as a spiral reverse bandage to the shoulder where it is finished as a spica bandage (see Fig. 137).

Chest Bandages. A *spiral bandage* (Fig. 151) is made as follows. A length of about one metre of bandage is unrolled and left to hang freely, the rest of the bandage being carried obliquely across the chest to the left shoulder (*2*) and thence obliquely across the back. The bandage begins in the lower part of the chest and, rising in spiral circular turns (*3*, *4*, *5*, *6*, *7*, *8*, *9* and *10*), encompasses the whole chest up to the armpits where it is fastened with circular turns. The freely hanging initial part of the bandage (*4*) is carried over the right shoulder and fastened in the back with the free end of the bandage.

Bandage for the breasts. A bandage supporting a woman's breast is very frequently used. Made for the right breast the bandage is usually carried from left to right, and for the left breast—in the opposite direction—from right to left so that it may better support the breast. The bandage begins with a circular side of the chest, whence, embracing the lower and medial part of the breast (Fig. 152), it is carried over the left shoulder (2), then obliquely

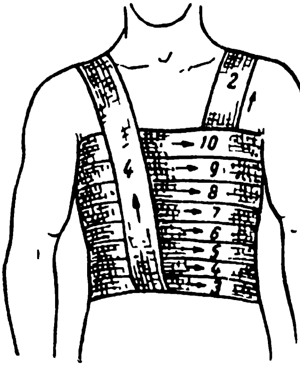


Fig. 151. Spiral bandage

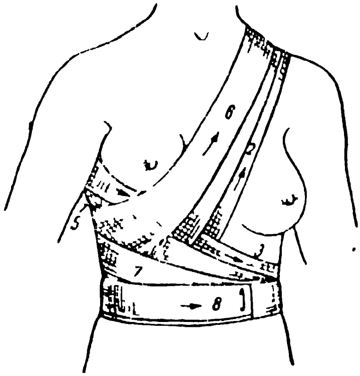


Fig. 152. Bandage for the breast

along the back to the right armpit; thence, embracing the lower part of the breast, the bandage fastens the preceding turn (3) by a circular turn and is again carried upward across the back, after which all the preceding turns (2 and 3) are repeated, etc. Gradually rising the bandage covers the whole breast; the last horizontal turns may be made over the breast.

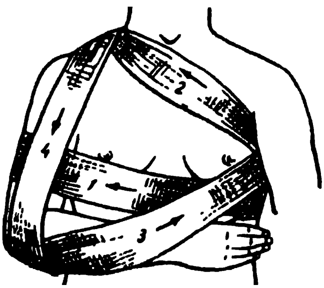


Fig. 153. Desault's bandage

Desault's bandage. Of the other bandages for the body mention must be made of the bandages fastening the arm to the body; they are used for fractures of the humerus, the clavicle, etc. Desault's bandage (Fig. 153) is the one most generally used. The arm flexed at a right angle in the elbow is pressed against the body, several circular turns with a bandage are made in the usual direction and the bandage must be fastened; then a new role is used for the second part of the bandage, the turns being made in the direction indicated by the arrow (Fig. 153,*1*). The second part of the bandage begins as

follows. From the armpit on the unaffected side the bandage is carried obliquely along the anterior surface of the chest to the patient's shoulder (*2*) and thence vertically downward along the posterior surface of the humerus under the elbow; then, while the elbow is supported, the bandage is carried over the shoulder to the armpit of the unaffected side (*3*), obliquely across the back to the affected shoulder, downward along the anterior aspect of the shoulder (*4*) and from front to back. Across the back the bandage is carried obliquely to the unaffected armpit, following which turns *2*, *3*, and *4* are repeated.

Velpeau's bandage. This bandage is used after reduction of dislocations and for injuries to the shoulder. The hand of the injured arm is placed on the unaffected shoulder and the arm is pressed to the body. The bandage is first carried horizontally, embracing the chest and arm, through the unaffected armpit and obliquely across the back to the injured shoulder, whence it is carried along the lateral surface of the shoulder under the elbow and to the armpit on the uninjured side.

Subsequently the turns are repeated, the horizontal turns being made below the preceding ones and the vertical—medially of the preceding ones.

Abdominal and Pelvic Bandages. A plain spiral bandage, from the top downward, might be enough for the abdominal region, but such a bandage is suitable only for the upper part of the abdomen because in the lower part of the abdomen a plain spiral bandage will move up, for which reason it has to be fastened to the thighs. The spiral abdominal bandage is therefore combined with a spica bandage or other pelvic bandages.

A *spica bandage* covers the lower part of the abdomen and upper part of the thigh, and may cover the buttock, lateral surface of the upper third of the thigh in the region of the greater trochanter and groin. Depending on where the bandage turns cross—in the back, on a side or in front—the resulting spica bandage is posterior, lateral or inguinal. We shall consider the inguinal bandage (Fig. 154). The bandage is fastened round the abdomen with a circular turn and, if the bandage is made for the right groin, it is carried from back to front across the lateral and then the anterior surface of the thigh (*2*). Passing on to the medial surface the bandage runs around the posterior semicircumference of the thigh and crosses the preceding turn in the inguinal region. Rising along the anterior surface (*4*) the bandage then runs around the posterior semicircumference of the body and proceeds to the inguinal region again, repeating the second and fourth turns. The bandage turns will be above the preceding ones (ascending bandage) or below (descending bandage); all the turns will cross in the inguinal region. The bandage is fastened with circular turns (*8* and *9*) round the abdomen.

Lower-Limb Bandages. A reverse spiral bandage is usually made for the region of the *thigh* and is fastened to the upper third of the pelvis with turns of a spica bandage. In the region of the *knee* turtle-type bandages are used for flexed knees and figure-of-eight bandages for extended knees. The circular and oblique turns are made above and below the knee with the crossings in the popliteal space (Fig. 155). Reverse spiral bandages, most frequently ascending, are made for the *shank*; to be strong, the bandage must cover the whole calf and reach the knee joint near which it is fastened with a circular turn.

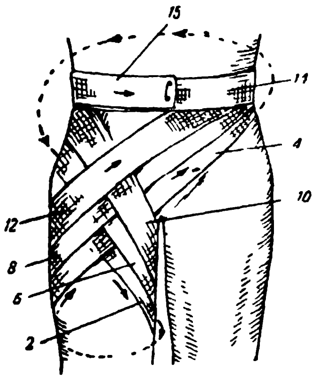


Fig. 154. Bandage for inguinal region

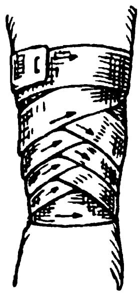


Fig. 155. Bandage for the knee

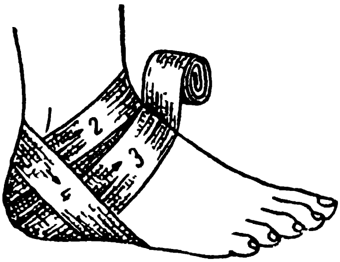


Fig. 156. Bandage for the heel

Heel bandage. The region of the heel may be covered with a diverging turtle-type bandage (Fig. 156). The bandage begins with a circular turn over the most protruding part of the heel, following which turns are added above (*2*) and below (*3*) the first one. It is desirable to fasten these turns with an oblique turn on the side of the heel, running from the rear to the front and under the sole (*1*), and continue the turns of the bandage above and below the preceding ones, covering the ankle above and the foot below. The turns of the bandage cross on the back of the curve.

Ankle bandage. To cover the region of the ankle joint, if the heel does not have to be covered, a figure-of-eight bandage may be used (Fig. 157). The bandage begins with a circular turn above the ankle (*1*), following which it runs obliquely across the back of the foot (*3*) and is raised on to the shank (*4*) crossing turn *2* over the back and, running around the posterior circumference above the ankles, proceeds obliquely across the back of the foot (*5*), then running under the sole goes up (*6*), etc. The entire back of the foot is covered with such figure-of-eight turns of the bandage. The bandage is fastened with a circular turn near the an-

kle. If the whole foot has to be covered, the bandage, after a circular turn at the ankle, continues with longitudinal turns running from the heel to the big toe along the lateral surfaces of the foot (Fig. 158). These turns are made very loosely, without stretching or they will flex the toes, which is very painful. On reaching the end of the toes the bandage embraces the foot beginning with the toes.

Other bandages. For *amputation stumps* recurrent bandages are made (see above). If the leg has been amputated somewhat below the joint, the bandage is fastened for strength above the

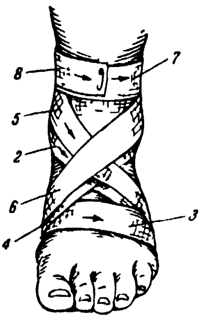


Fig. 157. Bandage for the ankle joint

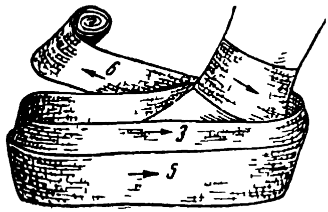


Fig. 158. Bandage for the whole foot

closest joint, for example, a spica bandage for the groin is added to the bandage of upper part of the thigh, a bandage for the knee joint—in injuries to the upper part of the shank. A bandage for the entire lower limb consists of a combination of the afore-described bandages.

Sometimes a particularly strong bandage is required, for example, for transporting and carrying the patient. In such cases the strongest bandage is used and is sewn with a thread at the crossings.

Frequently a more complex bandage, i.e., a bag for the scrotum (suspensorium), is used. A ready-made suspensorium is usually employed. A suspensorium can also be improvised, i.e., made from available material, for example from two strips of wide bandage fastened to the belt.

ADHESIVE BANDAGES

Adhesive plaster bandage. On a small wound the dressing material may be held in place by strips of adhesive plaster which, running over the dressing material, firmly adhere to the surrounding normal skin. Ordinary adhesive plaster must first be heated; adhesive plaster rolled on a spool requires no heating.

An adhesive plaster bandage is sometimes used for bringing

closer to each other the edges of granulating wounds. A strip of dressing material is placed on the wound and several strips of adhesive plaster across the wound (Fig. 159). The plaster holds the edges of the wound close to each other, and considerably accelerates healing.

A *cleol* (*mastisol*) *bandage* does not shrink or irritate the skin. Several cleol recipes have been proposed, the simplest one being 50.0 resin, 100.0 ether and 1.0 turpentine.

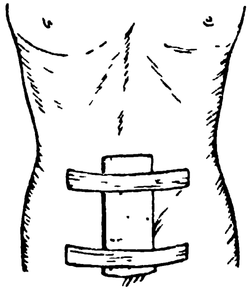


Fig. 159. Adhesive plaster bandage

The wound is covered with a sterile dressing and cleol is applied to the surrounding skin; when the cleol has somewhat dried (this moment is easily determined by touching the cleol-covered skin with a finger, thin threads appearing between the skin and finger as the latter is withdrawn), the entire region is covered with a stretched gauze napkin. The edges of the bandage which do not adhere to the skin are cut off with a scissors.

IMMOBILISING BANDAGES

In many diseases it is necessary to immobilise the affected part. The extremities can be immobilised by application of an immobilising bandage which prevents the affected part from moving and maintains it for a long time in a certain position. The immobilising bandage may be a removable splint or a hardening nonremovable plaster bandage.

SPLINTS AND SPLINT BANDAGES

Splints are very often employed for temporary immobilisation of the extremities. They are particularly frequently used for administering first aid and transporting the injured from the place of accident to a medical establishment.

A so-called *splint*, i.e., a piece of hard material of different shapes and character is a necessary part of any splint bandage. In addition to the splint, the bandage requires padding which is placed between the extremity and the splint; the padding serves to fill the cavities and recesses and to protect the bony projections from pressure exerted by the hard splint. Cotton or sheet wadding are used as padding, but in emergency cases any cloth or tow may be used, or the bandage may be temporarily made without padding. The injured extremity is firmly fastened to the splint with roller bandage or kerchiefs, leather straps or strips of cloth.

Splint bandages are particularly convenient in cases in which, for therapeutic purposes—dressings, massage, etc.—immobili-

sation must be temporarily discontinued, i.e., during inflammatory and purulent processes and injuries in which the bone is intact. The material, type and shape of the splints may differ very greatly.

Cardboard splints. If the cardboard is thin and bends easily, several layers must be used; if the strips of cardboard are short, they may be sewn together by placing one end on the other.

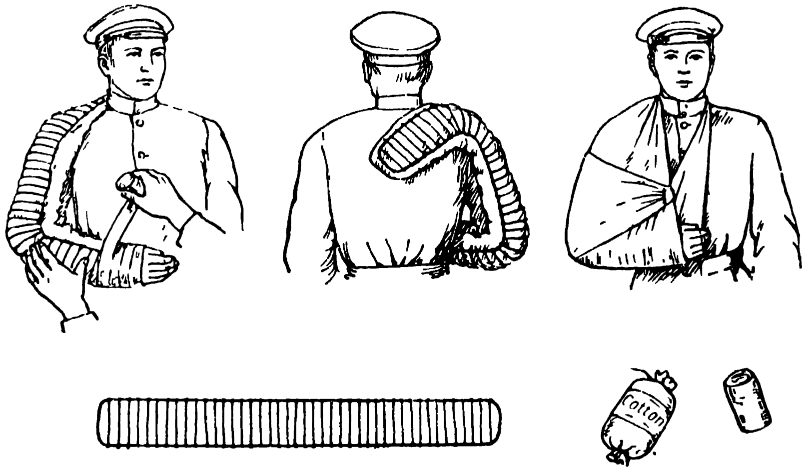


Fig. 160. Kramer's splint

Metal splints. Ready made splints of wire or thin sheets of different metals—white metal, zinc, iron and aluminium—are usually employed in hospitals. These splints have different sizes and shapes.

The most frequently used metal splints are made of two lengths of heavy wire with crosspieces (Fig. 160). These wire splints are

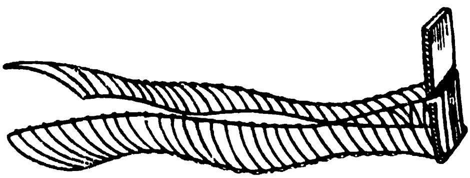


Fig. Kramer's splints for thigh and shank

light and flexible. By bending the crosspieces (Fig. 161) it is possible to make a trough. These splints find particularly wide application during administration of first aid to the injured who have to be transported. If long splints are needed, several wire

splints may be fastened to each other. The simplest application of a splint to the arm is shown in Fig. 160. The arm is flexed at a right angle in the elbow joint with the forearm supinated and the palm turned up. The splint is bent, fit to the contours of the arm and applied from the tips of the fingers along the ex-

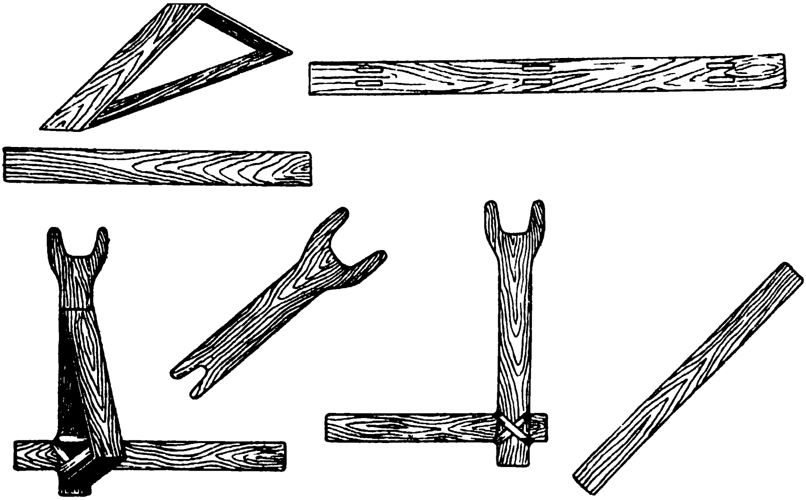


Fig. 162. Splints made of pieces of board

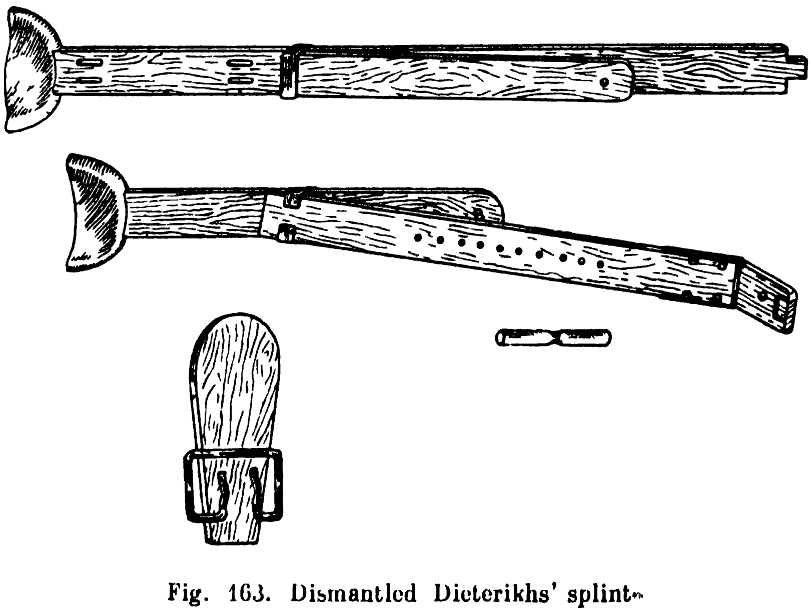


Fig. 163. Dismantled Dieterikhs' splint.

Fig. 164. Applying Dieterikhs' splint Fastening the sole

Fig. 165 Applying Dieterikhs' splint. The lateral splints are on

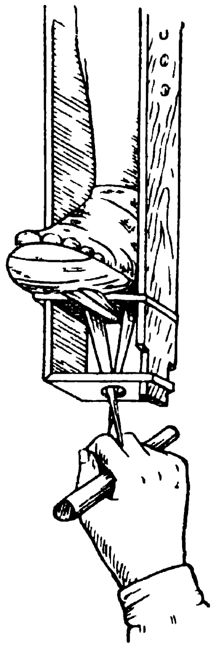


Fig. 166 Applying Dieterikhs' splint. Traction with the aid of a tourniquet

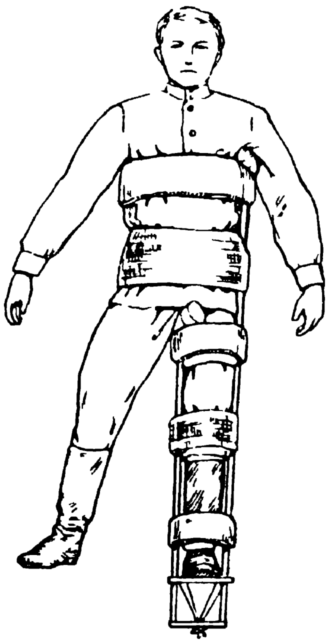


Fig. 167 Dieterikhs' splint

tensor side of the forearm and upper arm so that its top covers the scapular region on the back.

Application of a wire splint to the upper and lower extremities is shown in Figures 160 and 161. The extremity will be fixed more firmly if two wire splints are applied or one splint bent in the shape of a figure "II". The splint is bent in the form of a trough lengthwise, is adjusted to the contours of the extremity and is applied along its sides. A piece of plywood is placed and fastened in the middle of the splint which embraces the sole of the foot.

Wooden and other splints. Various wooden splints in the form of strips, boards and pieces of plywood are very popular. Such pieces of wood of different sizes and shapes should be prepared beforehand. By tying these pieces together it is easy to make splints of different shapes (Fig. 162).

Dieterikhs' special splint is used for fractures of the femur and tibia (Figs. 163-167).

PLASTER BANDAGES

Plaster is calcium sulfate calcined at a temperature of 100-140°C. It is easily ground into a fine white flour-like powder. Mixed with water the powder forms a paste which hardens into a solid mass. This property of plaster is utilised in application of bandages. Dry plaster absorbs moisture from the air, which negatively affects its hardening; to avoid this, plaster is kept in a dry place in metal boxes or glass jars closed with a tight-fitting plug.

Plaster bandages are used especially for injury to the bones and in certain inflammatory diseases, for example, inflammations of the joints, severe injuries to the soft tissues of the extremities, some diseases of the bones (tuberculosis), etc., when the affected part must be ensured complete rest.

The plaster bandage is kept on the patient for different periods of time—from several weeks to two months—depending on the disease.

Plaster test. Before using the plaster for a bandage it is necessary to ascertain its quality. Plaster must be an absolutely uniformly ground powder, without lumps or grains. It is best to test the plaster for hardening. A small amount of plaster is mixed with the same amount of water to produce a plaster paste the consistency of thin sour cream. This paste must harden within 5-6 minutes, i.e., on being tapped after this period it must produce the sound of a solid body and must not be deformed under pressure.

If the plaster is of low quality, it may be improved. If it contains lumps and grains it must be sifted and, if there is no sieve, it can be run through a loose gauze stretched over a bucket.

If the plaster hardens poorly because it is moist, it has to be calcined at a temperature not exceeding 120°C. For this purpose it is best to put the plaster on a pan for several hours into a heated stove.

Moistening with hot water, hot weak saline solutions, sodium sulfate, ammonia water or alum accelerates the hardening of the plaster, although alum makes the plaster more brittle.

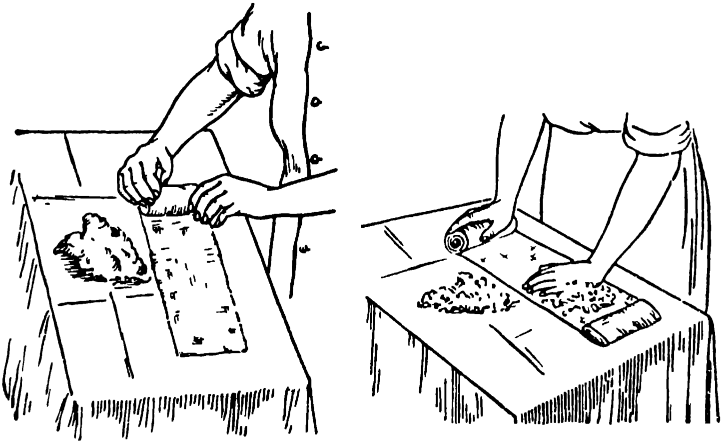


Fig. 168. Preparing plaster bandages

To slow down the hardening, cold water with an addition of joiner's glue or glycerine is used.

Preparing plaster bandages. Only white absorbent gauze may be used for preparing plaster bandages; unbleached gauze is not absorbent and therefore yields poor bandages. A bandage absorbs well only if it is not longer than 2.5-3.5 m and is rolled loosely. Plaster is placed on a table covered with an oilcloth (Fig. 168) or is poured into a flat pan. Plaster powder is placed on the end of the bandage and with strong movements of the hand is rubbed into the bandage, the excess plaster being simultaneously removed. Then the plastered end is carefully and loosely rolled. Then plaster is again spread on the unrolled part of the bandage, until the entire bandage is plastered. The plastered bandages are kept, like the plaster, in jars but are placed on their sides and not vertically, so that the plaster may not spill out of the bandages. It is best to use freshly-made bandages.

A plaster bandage applied to the naked body ensures greatest immobility and is used most, although in some cases a padding must be placed under the plaster. A padding is indicated in cases in which edema of the limb may form or in which the patient remains for a long time without adequate observation. Owing to the softness and resilience of the padding the compression and

unevennesses of the bandage will not be felt so intensely. The entire area to be bandaged is covered with an even layer of cotton or a strip of cotton is wrapped round the part. All the recesses where the bone is closer to the skin, for example, near malleoli, patellas, elbows, etc., and where pressure on these bony points may easily cause bedsores, are particulary carefully padded with cotton. To prevent the cotton from adhering to the hands and to make it stay on the bandaged part, the cotton must be first fastened in place with a usual bandage.

Before application a plaster bandage is placed in a basin with warm water; the layer of water over the bandage must equal the thickness of the bandage. When the bandage is saturated, which is indicated by the fact that air bubbles no longer escape from it, it is removed and slightly wrung out. The bandage should be wrung out so as to remove the excess water, making sure not to lose any paste. The roll must be wrung from the ends towards the middle (Fig. 169). Hard and improper wringing will also force part of the plaster out of the bandage or the plaster will lump up and will lie unevenly, making it inconvenient to apply the bandage.

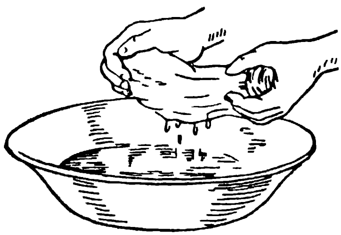


Fig. 169. Wringing the bandage

To prepare plaster-impregnated strips, the bandage is wrung

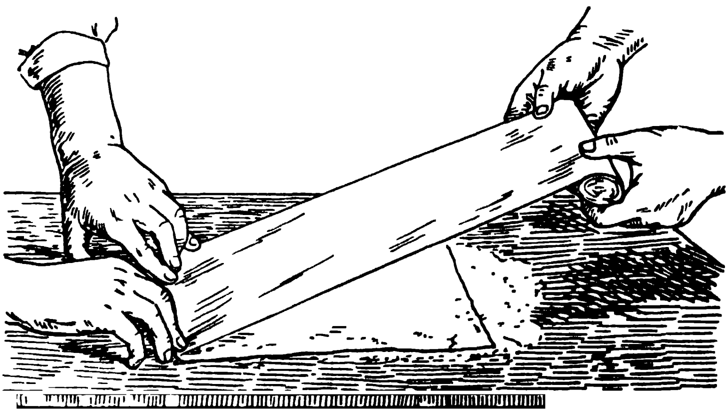


Fig. 170. Preparing plaster-impregnated strips

out, arranged in several layers (Fig. 170), one end of it is fixed and the bandage is evened and smoothed out (Fig. 171).

The plaster-impregnated strip applied to a limb is fastened

with a soft and sometimes circular plaster bandage (Fig. 172), and the limb is immobilised until the strip has hardened (Fig. 173).

During bandaging, each turn of the bandage covers two thirds of the preceding turn and the bandage evenly covers, without reverses, the whole part which has to be bandaged. Instead of

Fig. 171. Smoothing out plaster-impregnated strips

the reverses the bandage is cut on the opposite side or is straightened out. By the time the first bandage has been applied the second bandage must be ready, etc., until the bandage is thick enough,

Fig. 172. Bandage of plaster-impregnated strips

i.e., 2-3 layers on the upper limb, 3-4 layers on the shank and thigh, and 5-6 layers on the trunk. To make the bandage harden uniformly and lie well, it is necessary to work fast; this is achieved by practice, careful preparation and convenient distribution of all that is necessary for the bandage. To make the layers of the bandage adhere better and the bandage to correspond to all the unevennesses of the part being bandaged the bandage is carefully smoothed out after each layer and is fitted to the unevennesses (modelled). This is done by stroking the

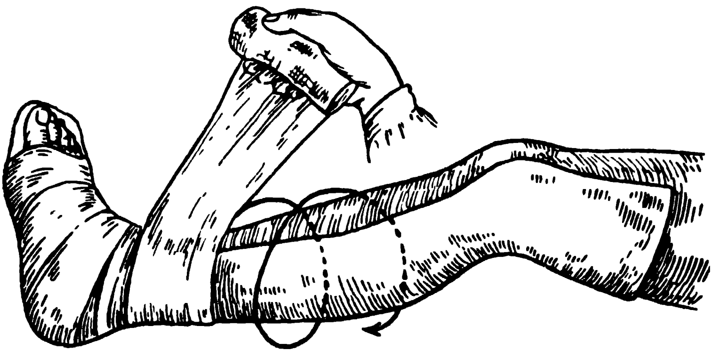


Fig. 173. Circular plaster-impregnated bandage

bandage until all the contours of the part being bandaged, for example, the crests of the ilia are no longer palpated. It is undesirable to apply the bandage in a heavy layer because a heavy bandage may exert strong pressure and cause necrosis of various portions of the skin (decubitus ulcer); the latter may also be produced by a poorly modelled and tightly stretched bandage.

Since the ends of the bandage begin to crumble when the bandage is worn for a long time and pieces of plaster may get under the bandage, it is desirable to fasten its ends. For this purpose the plaster is trimmed at the ends before the bandage has hardened. This is done in the following manner. The edge of the bandage is trimmed with a sharp knife and is drawn away, following which a circular strip 1-2 cm wide is carved with the knife. After this the lining is folded over the trimmed edge.

To apply a plaster bandage it is necessary to prepare: bandages impregnated with plaster, cotton (best in layers or rolls). plain bandages to hold the cotton in place, a basin to soak the bandages (for large bandages two basins for changing the water), a pitcher of water, scissors to cut the roller bandages, a knife to trim the plaster bandage, strips of cloth to fasten the ends of the bandage and, if necessary, splints.

While preparing and applying the bandages, it is necessary to watch that no plaster falls on the floor, because it easily sticks to the shoes and is carried all over the place. During bandaging the floor must be covered with a sheet. The remains of the plaster must not be thrown into the sink or the sewerage because on hardening the plaster will stop up the pipes. The plaster can easily be washed from the hands with a common salt solution. To prevent the plaster from adhering to the hands, the latter should be coated with vaseline.

A plaster bandage usually hardens within 5-15 minutes. During this period the affected part must be supported in the position which was imparted to it during the bandaging. Traction of the extremity and anesthesia are continued for the same length of time. The hardened bandage becomes hard to the touch and on tapping sounds like a solid body. It dries completely within 24 hours; from greyish it becomes snow white and on tapping it sounds more clearly and sonorously; scratching with a fingernail leaves no traces on it. On hardening, bandages made of good plaster become hot.

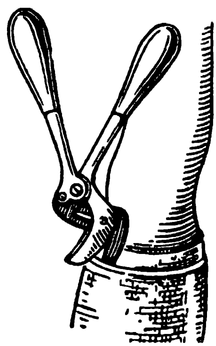


Fig. 174. Removing the bandage with plaster cast scissors

A plaster bandage spoils from moisture and must therefore not be allowed to become wet.

Removing a plaster bandage. It is easy to remove the bandage by cutting it with a special knife immediately after it has been put on, but it is difficult to take it off after it has hardened.

To soften the bandage, the latter is moistened with hot water, a common salt solution, or better still with a weak hydrochloric acid solution, after which it is cut with a sharp knife. The bandage may also be removed without being softened, for which purpose it is sawed to the padding or cut with plaster cast scissors (Fig. 174).

Technique of applying a plaster bandage. In putting on immovable bandages the general rules of bandaging must be observed much more carefully than when an ordinary bandage is applied. An improperly applied immovable bandage may do irreparable harm to the patient; even a slight uneven pressure may cause necrosis of the tissues at the sites of pressure and even a loss of the entire extremity, since immovable bandages are applied for a long time. The following are the most important rules of putting on a plaster bandage:

1. Before putting on the bandage the extremity must be placed in a position in which it may be fit for work.

2. Immobilisation, especially in fractures, must apply not only to the affected bone, but also to the two nearest joints—below and above the injury—and when bandaging the thigh it must apply to three joints. In injuries to joints the bandage must be put on over a long enough space, really to ensure immobility of the joints.

3. In putting on a bandage with padding the cotton is applied in an even layer, especially at the bony projections; it is best to use plain rather than absorbent cotton because it is more resilient and does not absorb perspiration.

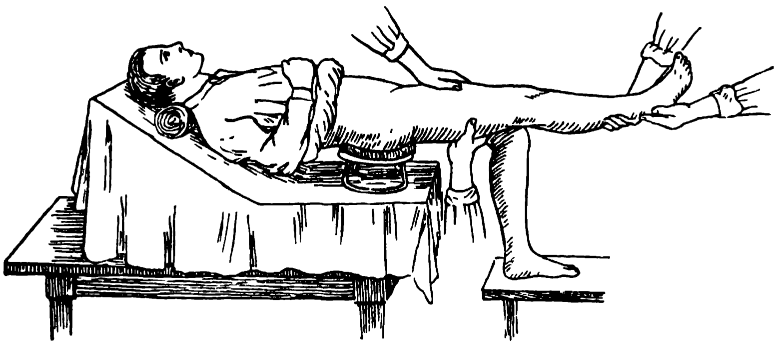


Fig. 175. Patient's position during application of a plaster bandage to the thigh

4. The bandage must be neither too tight nor too free.

5. Until the plaster has completely hardened it is necessary to watch that the bandage does not shift and, subsequently, does not exert too much pressure and in connection with the latter does not in any way disturb the blood circulation (cyanosis, edema, etc.). For the purpose of watching the limb the tips of the fingers are not bandaged.

6. All the materials required for the bandage must be prepared and arranged beforehand so that they may be easily and conveniently used.

7. The limb which is being bandaged must be accessible and absolutely immovable. The other parts of the body require firm support so that the patient may feel comfortable.

Bandaging is considerably facilitated if a proper position is imparted to the affected part, and the person doing the bandaging therefore needs rather competent helpers. The most difficult is to place the patient in a proper position for bandaging the upper part of the thigh and the region of the pelvis. In such cases the same supports may be used as in ordinary bandaging.

The patient is placed, as shown in Fig. 175, on the edge of the table. The uninjured leg is flexed in the knee and placed on

a stool. The pelvis is propped up with a support. It is desirable that the injured leg should be held by two assistants. More convenient are supports which are fastened to the edge of the table with a screw and which consist of a vertical rod resting against the perineum and a support for the sacrum capable of being moved along the rod to any height. The support for the sacrum is fastened

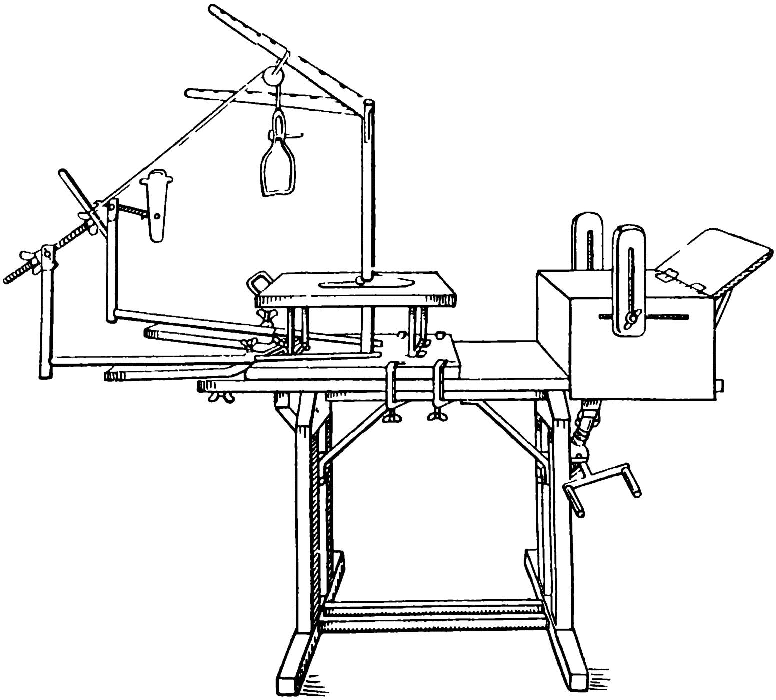


Fig. 176. Extension table with an additional box for the thorax, pelvic support and traction of lower limbs

at the necessary height with a special screw. Since bandaging with such supports requires a considerable number of assistants, special apparatus are sometimes used. Special extension tables (Fig. 176) are used for putting on complex plaster bandages under traction with reposition of fragments in fractures of the limbs. These tables are convenient because the wounds may be given primary treatment on them before bandaging (in open fractures and in injuries to the soft tissues).

In addition to the patient's position, *proper support of the injured part* during bandaging is also very important. It is particularly important in fractures. To make the limb immovable at the point of fracture, it is supported above and below the injury so that the position of the injured part is not altered and

no movement at the site of the fracture is allowed during the bandaging. If there are two assistants, one of them supports the injured limb above and the other below the injury with certain traction. The assistants must have good knowledge of the rules and methods of supporting the injured limb. When bandaging the upper arm the assistant stands on a side and somewhat to

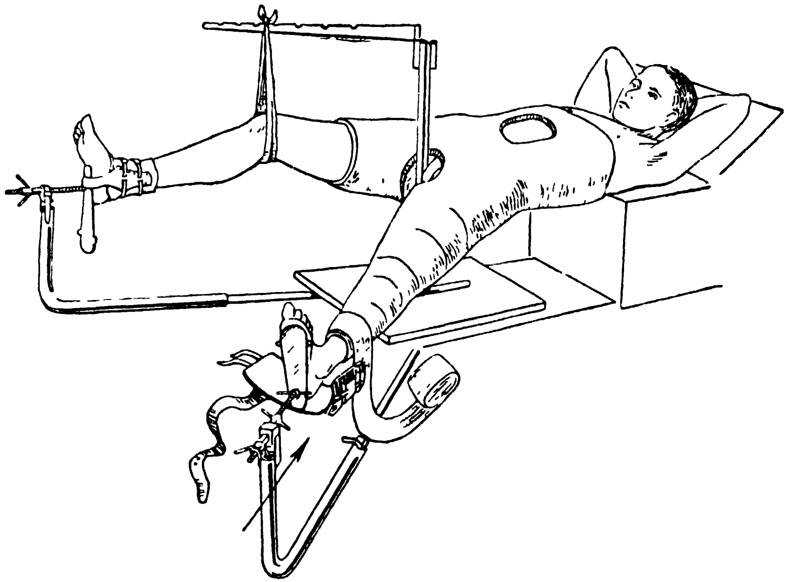


Fig. 177. Traction in coxitis

the rear of the patient; the assistant places one hand in to the patient's axilla and grasping the forearm below the elbow with the other hand abducts the arm and effects traction. During bandaging of the forearm the assistant holds the patient's upper arm with his left hand, grasps the fingers with his right hand and produces traction along the longitudinal axis of the forearm. In some cases it is necessary to support the limb, pulling separately the thumb and the three middle fingers (Fig. 178).

The foot is supported as follows: the area of the Achilles tendon is grasped with the left hand at the heel. The foot is flexed with the back of the right hand or it is held in place by grasping the toes but without compressing the bandage. During the bandaging it is necessary to watch carefully that the limb should retain its initial position, otherwise wrinkles or cracks are formed in the bandage. With wrinkles in the joint region or with a tight bandage the vessels may be compressed, which threatens subsequent necrosis of the limb.

It is difficult to support the limb when the hands are changed to let the bandage through; this must be done quickly and calmly, removing the hand and letting the bandage through without relaxing the general tension of the limb.

Plaster-impregnated strip hip-joint bandage. The most complex bandage on the lower limb is applied as follows: after placing the patient on a table and arranging the traction, the bandaging is begun with a protective application of gauze and cotton pads to the bony projections (Fig. 179).

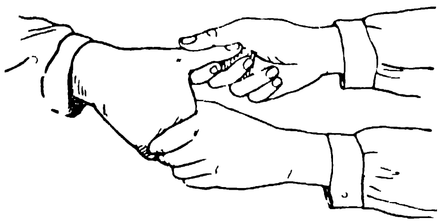


Fig. 178. Holding the fingers

After this plaster-impregnated strips are placed on the trunk and the pelvic region and are fastened with plaster bandages. The region of the hip joint (Fig. 180) and thigh is particularly carefully reinforced with additional plaster-

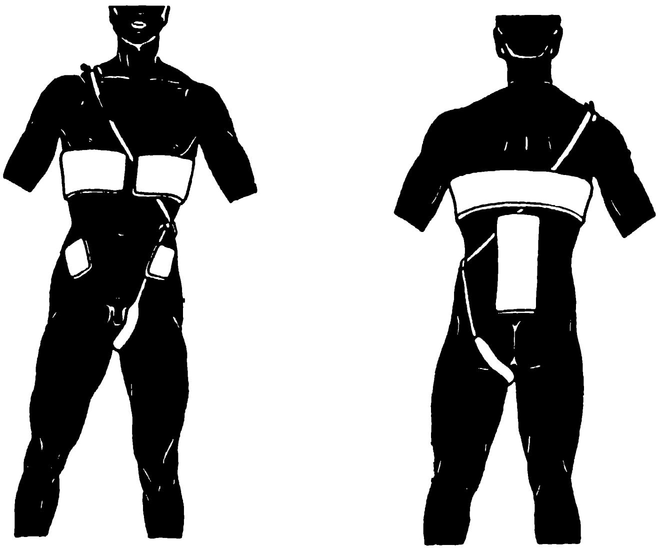


Fig. 179. Plaster bandage. Fastening cotton-gauze pads to the bony projection

impregnated strips. Lastly, the posterior plaster-impregnated strips are placed on the thigh and the region of the knee joint; the bandaging is ended by placing plaster-impregnated strips on the shank and foot (Fig. 181). The same figure shows the com-

pleted bandage fenestrated in the region of the stomach and its edges trimmed on the chest and in the region of the pelvis.

Removable immobilising bandage. To make dressing, massage and other medical procedures possible, a removable immobilis-

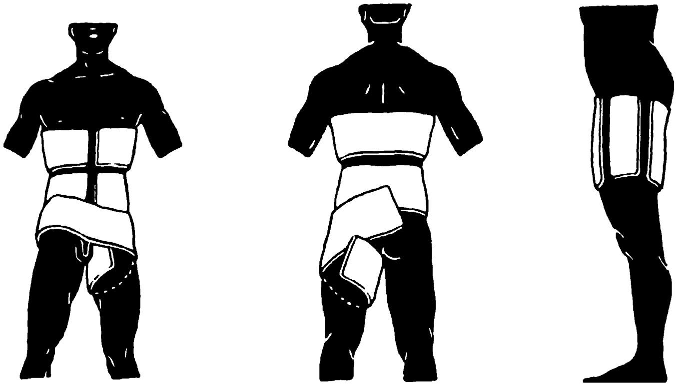


Fig. 180. Plaster bandage. Placing the plaster-impregnated strips

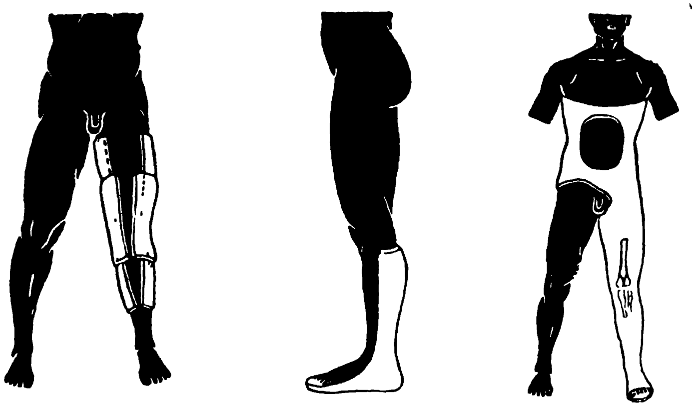


Fig. 181. Plaster bandage, applying plaster-impregnated strips and the finished bandage

ing bandage is used. At first an ordinary plaster bandage is put on,' but before hardening it is cut from two opposite sides and allowed to harden in two halves. The bandage is completed by placing these halves on the injured site and fastening them with a roller bandage. In cases of increased or diminished edema such a bandage makes it possible to regulate its pressure on the extremity by being loosened or tightened, although it is difficult to achieve complete immobility with it. Removable immobilising

bandages are convenient at the end of treatment of fractures, when owing to decreased edema the immobilising bandage becomes loose and has to be replaced or, by being cut in halves, be transformed into a removable immobilising bandage, or one half of it is used as a splint. If it is completely cut on one side, and trimmed on the opposite side it becomes a hinged bandage.

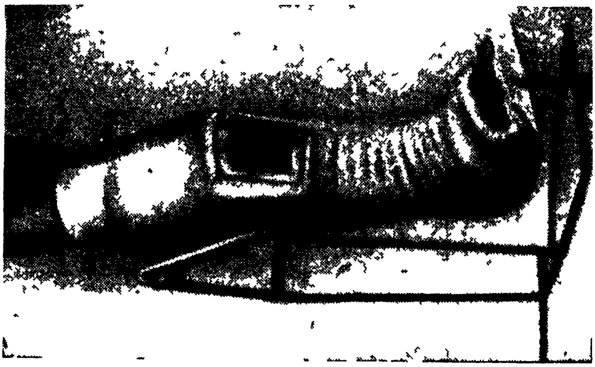


Fig. 182. Fenestral bandage

A *fenestral bandage* (Fig. 182) makes it possible to watch the wound and change the dressings on the extremities without affecting their immobility, which is very important in instances of open infected fractures. A fenestra over the injured site is made

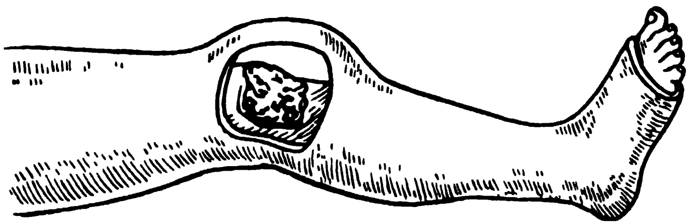


Fig. 183. Bridged bandage

during the bandaging or is cut out later. To prevent the pus and other discharges from the wound from running under the bandage, the fenestra is surrounded with cotton, preferably impregnated with a solution of shellac in alcohol or collodion.

Intermittent or *bridged* bandages are used in cases in which some part of the immobilised extremity must be left open around the entire circumference. To impart immobility to the separate parts of the bandage, the latter is connected above and below

the interruption with bars (bridges) of wood or metal which are covered over with turns of the bandage (Fig. 183).

Splint plaster bandages resemble the halves of removable immobilising bandages. The injured extremity is fastened with an ordinary bandage to a solid plaster bar or trough which precisely reproduces all the unevennesses of the injured extremity and therefore fits it snugly.

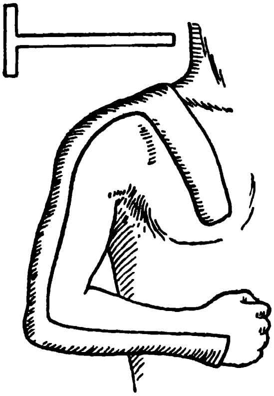


Fig. 184. Volkovich's splint plaster bandage

Such splints can be made from strips of grey cardboard wrapped in a wet plaster bandage and fitted to the injured extremity (Fig. 184).

Plaster-impregnated splint bandages. A plaster-impregnated splint bandage can also be prepared by another method. The gauze is cut according to pattern. Packed in 10-15 layers and impregnated with plaster. This makes plaster-impregnated splints which must only be moistened and smoothed out. Many plaster bandages are usually made with such plaster-impregnated strips which are held in place by turns of a plaster bandage.

TRACTION

Traction is employed: 1) for treating fractures, 2) for treating chronic inflammatory diseases of joints and bones (for example, tuberculosis), 3) for correcting contractures in joints, and 4) for preventing contractures during certain injuries to soft tissues. There are many methods of traction, but they can be divided into two groups: 1) gravity traction and 2) weight traction.

1. *Gravity traction* is frequently used *temporarily* when applying an immovable bandage, for example, to the spine. If traction is employed for a longer period of time, the weight of the patient himself can be utilised by placing the patient on an inclined plane (Fig. 185). If the patient is placed on a bed with the head of the bed raised and the foot of the bed lowered, he will slide down because of the force of gravity. If a special loop with a cord is attached to the head, the cord is passed through a pulley and a weight is suspended from the cord, the result will be continuous traction of the spine. This continuous traction is the stronger, the greater the inclination of the bed.

This method of traction is employed in tuberculosis and in fractures of the spine.

2. *Weight traction* is used in two forms: skeletal traction and traction with adhesive plaster. For traction with adhesive plaster

a long strip of plaster is attached to the injured organ (for example, thigh, upper arm or shank) along its axis, is bent in the form of a free loop over the region of the joint and similarly attached to the other side (Fig. 186); to ensure better attachment

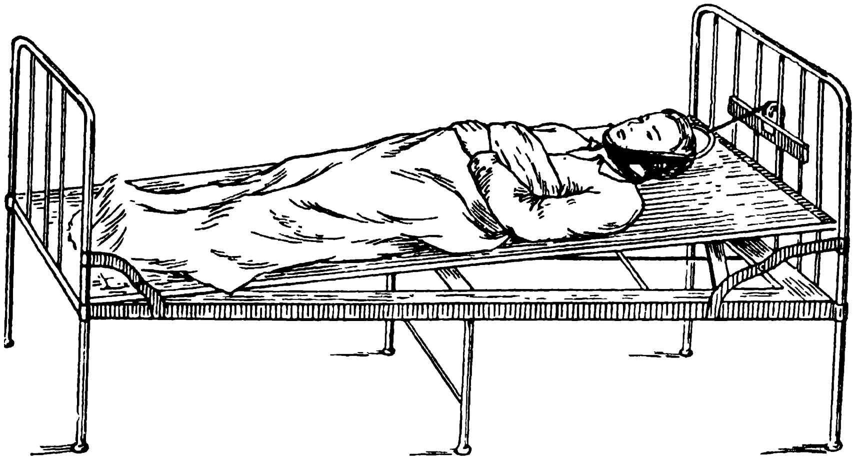


Fig. 185. Traction on an inclined plane

of the strip, the upper ends may be split longitudinally. A piece of board—thrust—is inserted in the loop of the plaster (Fig. 187); this thrust reduces the pressure of the plaster on the protruding parts of bones in the region of the joint (malleoli, condyles of the Femur) and serves for fastening the cord to it. The cord is

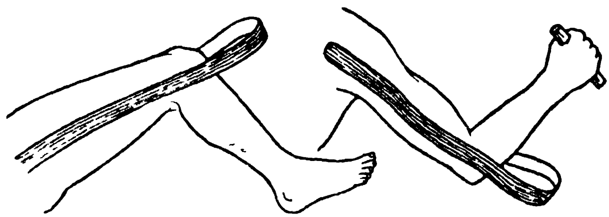


Fig. 186. Applying a strip of adhesive plaster for traction

fastened to the thrust in the following manner: a small hole is made in the centre of the thrust, the cord is passed through the hole and is fastened with a heavy knot on the inside. It is necessary to watch that the thrust is inserted properly (Fig. 188), i.e., perpendicularly to the strips of plaster and not obliquely. To prevent the strips of adhesive plaster from becoming detached, they are fastened by transverse loosely attached strips of plaster

2.5-3 cm wide and are bandaged over. At first light traction must be applied, but when the plaster grows soft because of the heat of the body and adheres firmly, the weight may be increased. Where the skin is directly over the bones and tendons, for example, the malleoli, narrow strips of muslin are placed under the plaster to protect the skin against pressure. The regions of the joints are left open. The injured places on the skin are circumvented by splitting the strip of plaster longitudinally and V-shaping its ends.

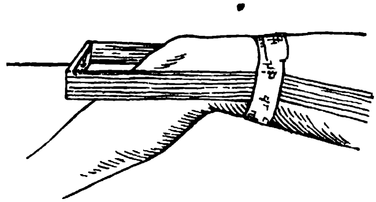


Fig. 187. Passing the loop around the knee

A plaster bandage stretches the skin of the limb and the skin transmits the stretching to deeper tissues, especially the muscles; this hinders displacement and ensures proper reposition of the bone fragments in fractures (Fig. 189). The cord fastened to the thrust is passed through a pulley, preferably through a system of pulleys (2-3), which creates more even traction.

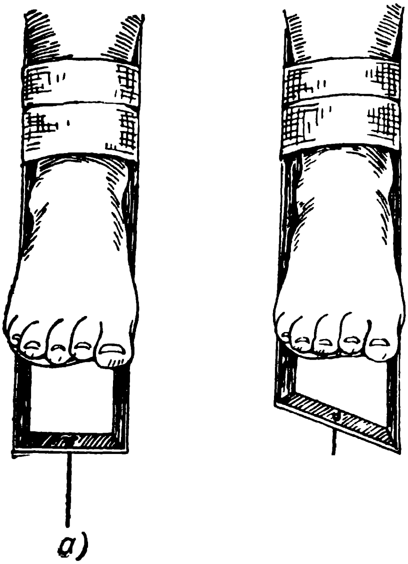


Fig. 188. Right way (*a*) and wrong way (*b*) of fastening a board

The pulleys are fastened to the bed (Fig. 190), or special uprights with pulleys are placed near the bed (Fig. 191)

It is necessary that the pulley should be on the level of the thrust centre, neither higher nor lower (Fig. 192). In this case the cord forms a single straight line with the middle line of the plaster strip, when viewed from the side, and a single straight line with the axis of the limb, when viewed from above. Moreover, the cord must not slide along the middle of the groove of the pulley which is placed upright.

Improper arrangement of the pulleys (Fig. 193), as well as a bend in the cord over the edge of the bed or upright (Fig. 194), reduces the effect of the traction.

The weight is fastened to the end of the cord so that it may hang freely without touching anything nearby and at a certain distance from the floor. Bags with sand or special weights

are used for traction (Fig. 195), making it possible gradually to increase the load without discontinuing the traction. For skeletal traction see page 228.

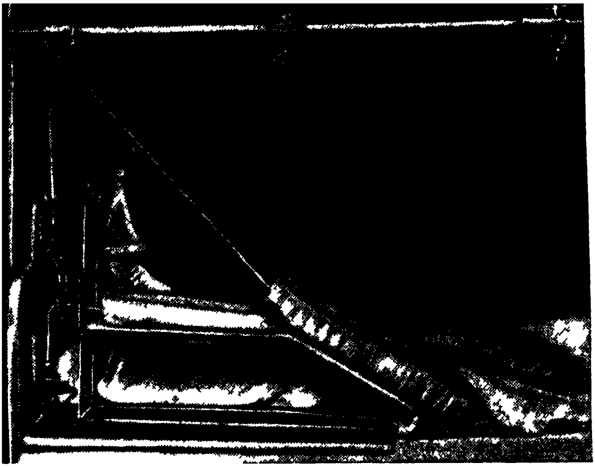


Fig. 189 Adhesive plaster traction

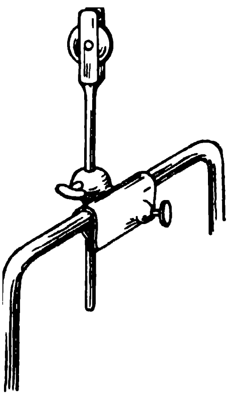


Fig. 190 Pulley

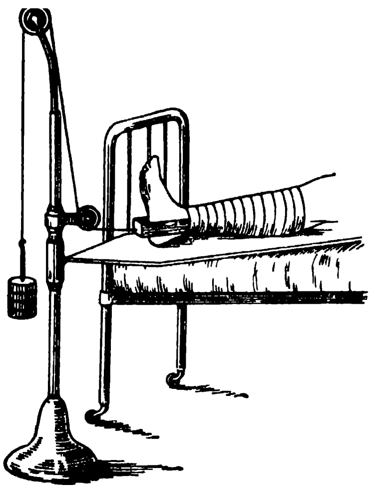


Fig. 191 Upright with pulleys

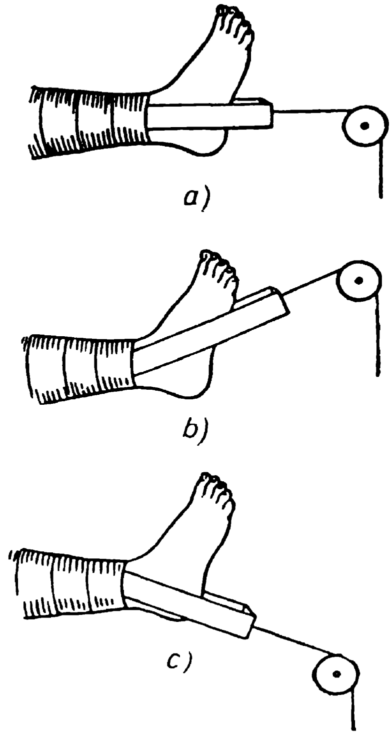


Fig. 192. Right way (a) and wrong way (b and c) of placing the pulley

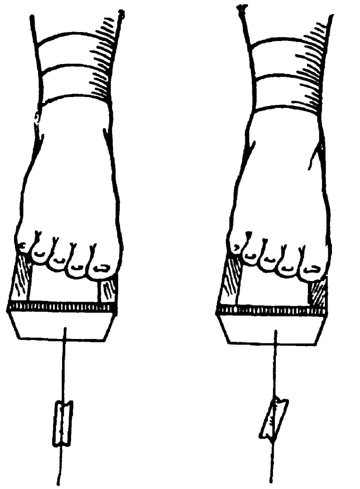


Fig. 193. Right and wrong positions of the axis of the pulley

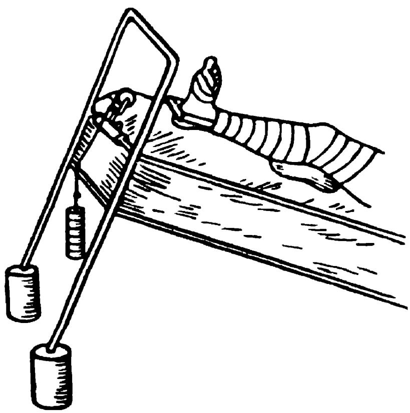


Fig. 194. Improper employment of traction

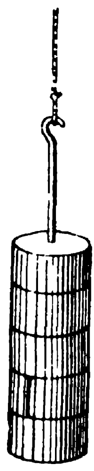


Fig. 195. Weights for traction

INJURIES (TRAUMAS)

Any damage to the tissues produced mechanically, chemically, electrically or by any other extrinsic agent is called a trauma or injury.

There are two types of injuries: open and closed. In closed injuries the skin and mucous membranes are intact, uninjured. In open injuries the integrity of the skin or the mucous membranes has been violated. Open injuries are also called wounds.

Closed injuries include contusions, sprains, ruptures, dislocations and fractures. Depending on the instrument with which the wound was made and the character of the disturbance in the tissues and organs, the following wounds are distinguished: incised, slashed, puncture, lacerated, contused and gunshot wounds.

Every trauma produces not only *local* changes in the tissues and organs of the region directly acted upon by the extrinsic agent, but also a number of *general* disorders in the organism, mainly in the central nervous system, especially in cerebral activity. The most important and most frequently encountered general disorders are syncope, concussion of the brain, shock and collapse.

Syncope. During syncope the patient suddenly becomes pale, his respiration rapid and shallow, and the pupils dilated and immovable; the patient loses consciousness and falls. This condition does not last long. Within several minutes the patient regains consciousness. Rapidly developing cerebral anemia due mainly to spasm of the blood vessels is considered the cause of syncope.

To prevent syncope in surgical patients during all extensive dressings, it is necessary first of all to make the dressing painless. Before a painful dressing patients are administered narcotics (1 ml of a 1 per cent morphine solution subcutaneously) or are anesthetised (nitrous oxide).

Aid in syncope consists in restoring the blood circulation, in order adequately to supply the brain with blood. The patient is

placed in a horizontal position with head lowered and legs raised, his collar is unbuttoned and everything that interferes with respiration (belt, braces, etc.) is removed; the patient is given to smell ammonia water and his face is sprinkled with cold water. After this the patient, in most cases, quickly regains consciousness.

Collapse is sudden extreme exhaustion with weakening of cardiovascular activity, cardiac symptoms coming particulary to the fore.

The picture of collapse includes cyanosis, cold perspiration, dilation of the pupils, rapid and barely palpable pulse, clouded consciousness, fall of temperature and frequently shallow respiration. Treatment of collapse must be directed at eliminating its causes; for example, during hemorrhages the patient must be administered whole blood transfusions or transfusion of blood substitutes; Vasoconstrictive drugs and cardiacs are also useful. Strong coffee and tea (if the patients can swallow) are advisable; the patients are kept warm by means of hot water bottles and are carefully watched because collapse may recur.

Shock is one of the severest complications of wounds, injuries, grave operations and widespread burns. Shock is particularly significant under war conditions because it ends fatally in many cases. The following is a description of shock made by the famous surgeon N. Pirogov:

"You see a wounded soldier without an arm or leg lying stock-still at the dressing station; he does not shout, moan or complain, but is indifferent to everything and does not ask for anything; his body is cold and face pale as those of a corpse; his eyes are immovable and he gazes into the distance. His pulse is like a thread, barely palpable and intermittent. He either answers no questions at all, or answers them under his breath, in a barely audible whisper; his respiration is also barely noticeable. His wound and skin are almost completely insensitive, but if the major nerve hanging from the wound is in any way stimulated, the patient displays a sign of sensation only by contraction of the facial muscles. Sometimes this state passes within a few hours and sometimes it persists unchanged until death."

The essence of shock and its genesis (development) are not well enough known as yet. Experimental data and clinical observations warrant the assumption that the nervous system plays the leading role in this affection.

The problem of the genesis of shock is solved on the basis of I. Pavlov's teaching, considerable importance being attached in the mechanism of its development to exhaustion of the cerebral cortex under the influence of the harmful action of the stimuli (pain, intoxication, mental stress).

An enormous part in the development of shock is played by

physical overstrain, protracted insomnia, exhaustion and starvation, cooling, hemorrhage, emotional disturbance, etc.

The stimulation transmitted to the central nervous system at first excites and then depresses the vitally important centres, including the vasomotor centres. As a result, vascular tone diminishes, the internal vessels in the abdominal cavity dilate and accumulate a lot of blood, so that the peripheral arterial system is drained of blood and the blood pressure drops. The patient's condition is aggravated by absorption of the products of decomposition from the region of the injury which is a source of intoxication.

Surgical, postoperative shock is fostered by a protracted operation, incomplete analgesia or incomplete anesthesia, unrestored loss of blood, a painful operation and an operation in particularly sensitive parts.

Clinically, primary shock, immediately following the injury and secondary shock, developing sometime after the injury or the operation, are distinguished. They are produced by the pain impulses coming from the point of injury (i.e., during transportation over bad roads and by insufficient immobilisation of the injured extremities) as well as by absorption of the products of tissue decomposition.

Two periods may be distinguished by the picture of the disease: erethistic (with excitation) which is brief and not always perceptible, and torpid which includes the foregoing description of the picture of the disease made by N. Pirogov.

Excitement, fear, restless movements in the extremities, insomnia, flushed face, rapid and weak pulse are observed during the erethistic period of shock.

The torpid period of shock is characteristic for the patient's apathy and indifference (with consciousness retained), pulse accelerated to 120 and more beats per minute, drop in blood pressure, shallow and rapid respiration, low temperature and decreased excretion of urine. Examination of the patient reveals pallor of the skin and mucosa, cold perspiration, drawn face and dilated pupils poorly reacting to light. Not infrequently nausea, hiccups and vomiting are observed.

Prophylaxis. To prevent shock, the patient is given complete rest. Thoughtful care and considerate treatment of the patient are particularly important, because of their favourable psychological effect. In cases of very painful injury (for example, in open fractures of the extremities and in cavitary injuries), the situation requiring evacuation of the injured, the most comfortable and rapid form of transportation is necessary (transportation by air). Under war conditions the severely wounded must be administered 1-2 ml of a 1 per cent morphine solution or 1 ml of a 2 per cent pantopon solution and must be given alcohol.

Moreover, it is necessary quickly to arrest the hemorrhage, make the patient warm, give him stimulating drinks (hot tea and coffee) and treat him considerately.

Treatment. In the first place it is necessary to eliminate, if possible, the causes of shock, namely, the pain sensations, arrest the hemorrhage, etc. Particular caution is required during transportation of such patients and during administration of surgical aid, because the slightest intensification of pain will aggravate the patient's condition.

The main objectives in treating shock are the following: 1) interruption of the conduction of pain impulses by a novocain block or production of general anesthesia; 2) diminution of reactivity of the central nervous system by administration of narcotics (morphine, pantopon, alcohol); 3) improvement of circulation by administration of cardiacs (camphor, caffeine) and by intravenous infusion of large amounts of physiologic saline solution, glucose, antishock fluids, and blood transfusions; 4) control of factors aggravating shock (intoxication, loss of blood, etc). As in syncope, the head of the patient who is in a state of shock is lowered, measures are taken to keep the patient warm and the patient is given to drink, if he can swallow. At the same time the patient is administered stimulants: ether-valerian drops, strong coffee, tea, wine and whiskey; adrenalin, camphor, and caffeine are injected subcutaneously.

Of enormous importance in controlling shock are intravenous infusions of large amounts (up to 1,000 ml) of physiologic or other saline solution—blood substitutes, and 5-10 per cent glucose solution. The infusions are made slowly and are repeated several times. During shock the best result is produced by blood transfusion which must be administered at the very first opportunity.

Even mild forms of shock may cause rapid death. If the patient is brought out of the state of shock, all the symptoms quickly fade, but the patient's general condition may become aggravated again.

Only the most urgent operations to save the patient's life, for example, arresting a hemorrhage, are performed during shock. In all other cases the patient must first be brought out of the state of shock and given a blood transfusion, and be operated on later. Transportation of the patient, especially over long distances, is permissible only after elimination of all the phenomena of shock.

OPEN INJURIES

Wounds. Any injury involving a break in the skin and mucous membranes is called a wound.

Depending on the nature of the wounding instrument and the type of wound the following wounds are distinguished: incised, slashed, puncture, contused, lacerated, and gunshot wounds.

Incised and puncture wounds are noted for the fact that their edges and walls have sustained little damage and have remained quite viable. Unlike these wounds, contused, lacerated and gunshot wounds involve a crushing of the tissues of their edges and walls.

Incised wounds are inflicted by sharp objects (knife, dagger, glass, etc.) *and may have a linear appearance as well as an appearance of a flap.* Incised wounds also include all surgical wounds.

Owing to the elasticity of the skin, the edges of incised wounds part ("gaping wound"). It is therefore usually easy to examine the entire wound cavity and ascertain what particular tissues and organs have been injured.

The degree of gaping of an incised wound depends on its location and direction. The wounds running along skin folds, for example, transverse cuts on the neck, the abdominal wall, etc., gape the least. On good contact of the edges such wounds leave barely perceptible cicatrices after healing.

Of considerable importance for a favourable course of an incised wound is the character of incision of the tissue. In wounds inflicted by a sharp cutting instrument the edges of the incised tissues are scarcely damaged (wounds with small zone of injury), owing to which *no favourable conditions for development of infection are created in incised wounds*, and the latter not infrequently heal by first intention. *Surgeons take advantage of this property of incised wounds and suture not only surgical but, after suitable treatment, also accidental incised wounds.*

Incised wounds are very much less painful than other types of wounds because of insignificant injury to the nerve endings.

Incised wounds bleed more than contused wounds. In cases of incised wounds in vessels their edges are scarcely crushed and their internal coat (intima) sustains little injury. Blood clots which plug up the wound of a vessel and help in arresting hemorrhage are formed near the scraps of the crushed intima. But, since incised wounds do not have such crushed tissues, the injured vessels in them tend less to spontaneous formation of thrombi.

Slashed wounds made by a sword, sharp axe, etc., are closely related to incised wounds but, unlike incised wounds, they are characterised by considerable injury to bones (skull, extremities, etc.).

Puncture wounds are made by pointed instruments (nail, bayonet, dagger), a deep wound canal with an insignificant external opening being most characteristic of these wounds. Owing to displacement of the tissues after the wound has been inflicted, the wound canal is not infrequently sinuous rather than straight. It is often difficult to judge, by the external appearance of such a wound, its depth and extent of injury to the organs, because even in small skin wounds the wounding instrument, especially

such as a dagger, frequently penetrates very deeply and considerably injures the internal organs. *Cavitary injuries* (when the wounding instrument gains entrance into the abdominal or thoracic cavity) and injuries to the internal organs are not infrequent in puncture wounds. With a *deep wound canal large vessels* are very often injured, in which cases considerable hemorrhages may occur not to the exterior but *into the tissues or, what is still more dangerous, into cavities* (thoracic, abdominal). The person administering aid may not notice such hemorrhages. Foreign bodies sometimes remain in wounds because the wounding instruments (knife, dagger) may break on striking against a bone. The hemorrhages into the tissues and the sinuous and narrow wound canal render the discharge of pus difficult, as a result of which pus accumulates deep between muscles; in such wounds the infectious process not infrequently runs an unfavourable course.

Puncture wounds necessitate surgical intervention during the first hours after the wound has been sustained, especially in cases in which vessels, tendons and other tissues are known to be injured deep in the wound. In puncture wounds of the cavities (thoracic, abdominal) signs of injury to the internal organs are sometimes noted when it is already difficult to save the patient because of the internal hemorrhage or developing infection (peritonitis). In such wounds surgical intervention is indicated when there is a suspicion of a penetrating cavitary wound.

Everything concerning cavitary gunshot wounds also holds true of the puncture cavitary wounds.

Contused wounds are made by *blunt instruments and objects* (different kinds of work tools, stones, animal hooves, etc.).

Wounds may be lacerated, contused, crushed, avulsive, etc. *The characteristic feature of contused wounds is a large amount of unviable, bruised and crushed tissue along their edges.* Such wounds favour development of infection. *Contused wounds are therefore very frequently infected,* the purulent process running a protracted course, to the point of complete disengagement of the necrotic tissues. The primary treatment of such wounds consists in resection of their edges and floors and removal of the injured tissues from them.

A distinguishing feature of contused wounds is a relatively insignificant hemorrhage even in cases of injury to larger vessels. For example, during evulsion of the extremities by the wheels of a tram-car or railway train there is no extensive hemorrhage. In contused wounds the intima (innermost coat of the blood vessels) usually sustains considerable injury. Its scraps are twisted, drawn upward into the lumens of the arteries and thus foster rapid coagulation of the blood and formation of thrombi which plug up the lumens of the vessels.

Gunshot wounds. Gunshot wounds vary very greatly, depending on the type of the firearm with which they were made. They include bullet wounds (rifle, revolver and machine-gun), shot (shotgun) and splinter wounds caused by splinters from exploded mines, artillery shells, air bombs and hand-grenades. Bullet wounds are less dangerous, as regards development of infection, than are wounds inflicted by shell splinters.

Gunshot wounds are divided into tunnel and blind wounds. Tunnel wounds are such in which the bullet, shrapnel or shell splinter go *through* the body making two wounds—wound of entrance and wound of exit. *The wound of entrance is usually smaller than the wound of exit*, the edges of the latter not infrequently being averted which is easy to see when bony fragments are carried along by the bullet or splinter and tear the soft tissues and skin at the wound of exit. If the bullet, shrapnel or splinter get stuck somewhere in the tissues, such wound is called a blind wound. If the foreign body is easily found during primary surgical treatment it is removed. Not infrequently the foreign body, which was not removed at first, has to be removed much later if it supports a purulent process, damages important organs, etc. In some cases the foreign body (bullet, splinter) remains in the body for many years without in any way discomforting the patient. If the foreign body does not discomfort the patient, is difficult of access and its removal is dangerous, it is left in the body.

If the wounding object has touched the body only superficially it produces a wound in the form of a weal without either an entrance or exit hole. Of course, these injuries are the lightest, except injuries inflicted by large shell splinters when even a superficial wound is accompanied by extensive and severe injuries to the tissues.

Of enormous importance in gunshot wounds are injuries to soft tissues and internal organs. Particularly important are cavitary wounds, i.e., penetrating into cavities and injuring the organs of the abdomen, chest and skull. These injuries are in the foreground of the entire picture of the disease. Cavitary wounds are responsible for high mortality, especially if the wounded have not immediately been operated on. Injuries to vessels producing profuse hemorrhages play a very important part.

Regeneration of tissues in injuries. In injuries tissues are destroyed by direct mechanical damage, and disorders of nutrition caused by disturbances in blood circulation (injury to the vessels) or by impaired innervation. The subsequent healing of the wound consists in resorption of the necrotic tissues and formation of new tissue, mainly connective, with subsequent formation of a cicatrix. Regeneration of tissues and healing of wounds depend on the condition of the wounded. A healthy young organism favours rapid healing of wounds, whereas in an emaciated patient

the healing of a wound may take a very long time and produce a number of complications.

Healing of wounds also depends on the character of injury to the tissue, as well as the state and peculiarities of the injured tissue.

The more differentiated the tissue, the more poorly it regenerates. Thus, the cells of the central nervous system, parenchymatous organs and muscular tissue are destroyed by injury; they are almost incapable of regeneration and the wound heals by forming a connective tissue cicatrix. Regeneration is also impeded by considerable destruction of tissue in virtue of circulatory disturbances.

The extent to which the wound is infected is extremely important. In tunnel bullet wounds of the soft tissues the infection may penetrate into either the wound of entrance or the wound of exit from adjacent sections of the patient's skin, the clothing, etc. If the infection does not develop, a slight swelling is observed at the point of injury, the wounded runs a slight fever, and develops a slight inflammatory process around the wounds of entrance and exit. Such wounds sometimes heal within a weak, while both the wounds of entrance and exit are covered with a crust and the healing goes on under the crust.

Splinter wounds are usually the most infected. A shell splinter has, as a rule, an irregular shape and jagged edges. It carries with it deep into the tissues earth, pieces of clothing, contaminated skin of the wounded, etc. All these objects contain a highly virulent flora (anaerobic microbes in particular). A splinter inflicts severe injury to the soft tissues and crushes them; it often lacerates nerves and vessels, which leads to internal hemorrhage. All this creates favourable conditions for development of infection in splinter wounds.

It should also be noted that splinter wounds are often multiple and the splinters may be of different sizes.

By hitting a bone the wounding object breaks it into fragments and each such fragment piercing the soft tissues becomes a secondary wounding object which aggravates the severity of the wound. In such cases still more favourable conditions for development of infection are created.

First aid to the injured. In addition to arresting hemorrhages, the objectives of first aid to the injured include protection of the wounds from infection. A properly applied first dressing will protect the wound from microbes and this will favour its healing.

Dispensaries, reception rooms in hospitals and first aid centres must always keep in readiness sterile dressing material in drums or special packages.

The patient's clothing is removed or cut open, the hair is clipped or shaved, the circumference of the wound is cleaned and the edges of the wound are painted with iodine tincture.

Small wounds are painted with iodine tincture all over the wound surface.

The wounds contaminated with earth, splinters of wood, etc., may be carefully cleaned by removing the dirt with forceps or gauze after which the contaminated parts must be painted with an iodine tincture. Sometimes the wound is dusted with sulfa

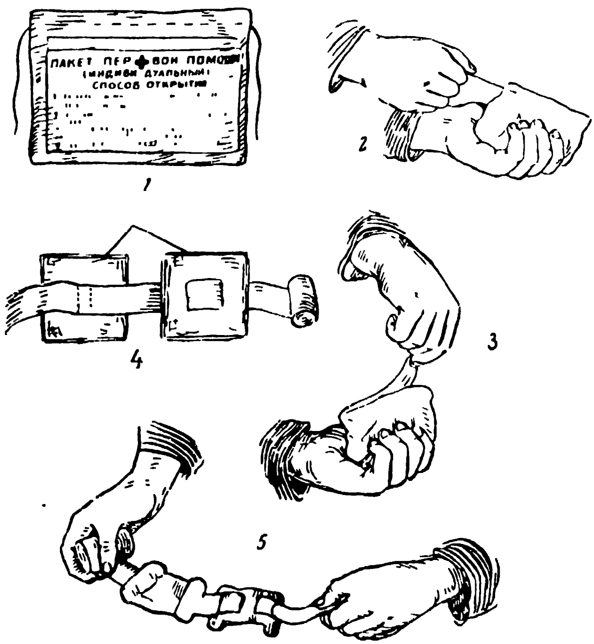


Fig. 196. First aid packet (figures show the sequence of opening the packet)

drugs; the deeper parts of the wound and deeper tissues must not be touched.

The dressing material must be placed on the wound without being touched with the hands, after which it must be covered with a layer of cotton and fastened with a bandage or kerchiefs.

The first dressing can be conveniently applied by using an individual packet which contains sterile (antiseptic) dressing material in a waterproof bag. A first-aid packet consists of two small cotton and gauze compresses (Fig. 196). One of the compresses moves along the common bandage designed for keeping it in place, while the other compress is immovable at the free end of the bandage. To fasten the dressing provided in an individual packet, the latter contains a safety pin. Sometimes it also contains an ampule with iodine tincture.

After the clothing from the wounded part has been removed the first-aid packet is opened. The pin for fastening the dressing is laid aside. If the packet contains a glass ampule with iodine tincture, the ampule is crushed and the cotton or gauze in which the ampule is wrapped becomes saturated with the iodine tincture. The resultant swab is used to paint the edges and circumference of the wound. Then the bandage is unrolled without touching the inner surface of the dressing.

It is very easy to apply compresses to blind wounds and somewhat more difficult to tunnel wounds. The compress fastened to the free end of the bandage is placed on one of the openings, while the other compress (movable) is moved along the bandage until it reaches the other opening; the inner side of the compress must not be touched by hand. When both compresses are in place they are fastened with the bandage and pinned.

The most important thing is to bandage the wound without touching the inner side of the compresses which contact the wound.

When administering first aid for all types of wounds it is necessary to make a preventive (prophylactic) injection of antitetanic serum. The injection of 1,500 antitoxic units is made subcutaneously.

Primary treatment of wounds. The main aim in treating a wound is to prevent development of infection in it. An infection which has gained entrance into a wound does not in any way manifest itself during the first hours, since the bacteria have not as yet multiplied and are there in small numbers. This period lasts 6-12 hours after which the microbes reproduce abundantly and penetrate into the deep layers of the tissues; within 24 hours the lymph spaces and vessels are replete with microbes. Surgical aid must aim at removing the microbes from the wound if possible during the first hours of the injury and, what is most important, eliminate the conditions favouring the development of microbes in it. This is achieved by primary treatment of the wound.

By dissection of the wound and excision of its edges, walls and floor, the microbes, as well as the crushed unviable tissues which are a good medium for the development of infection, are eliminated. At the same time the foreign bodies are removed from the wound and the hemorrhage is arrested.

Primary treatment of the wound yields the most favourable results if it is administered during the first six hours after the wound was sustained. In some cases in which all the injured and infected tissues have been excised and the patient remains under observation of the physician the wound may be sutured.

It is usually impossible completely to excise war wounds. Primary treatment therefore consists in their dissection, excision of the devitalised tissues, debriding of pockets and sequestra, arresting hemorrhage, administration of sulfa drugs and anti-

biotics into the wound and application of a dry dressing or dressing impregnated with antiseptics (ointment dressings, etc.).

Penicillin may be administered as injections and dusting in doses of up to 4,000,000-5,000,000 u. Antibiotics are given intramuscularly for a period of 5-7 days immediately following the injury.*

Many surgeons use for anesthesia a novocain solution containing penicillin.

Primary treatment of the wound later than six hours after the injury has been sustained yields poorer results than the same treatment administered during the first six hours. Application of sulfa drugs and antibiotics (locally, to the wound) ensures sufficiently effective treatment even at later periods—within 12-24 hours after the wound has been sustained.

Still better results are produced by administration of penicillin locally (into the wound and intramuscularly) and streptomycin.

It should be noted that if the wounded is delivered within more than 24 hours after he has sustained the wound the primary treatment of the wound is in many cases much less effective. It follows that it is very important to begin surgical treatment of the wounded during the very first hours after the injury has been sustained.

Healing of Wounds. *Purulent and nonpurulent wounds.* Healing of a wound is conditioned by its character, its infection with microbes, the condition of the wounded, etc. Two types of healing are distinguished, according to the development of the wound process. The first type is characterised by the fact that the contacting edges of the wound adhere to each other without discharging any pus and subsequently form a linear cicatrix, the entire process of healing terminating in a few days. Such a wound is called a clean wound and its healing—healing by first intention (prima intentio). If the wounds are gaping or their edges subsequently part because of development of infection, they are only gradually filled out with special newly-formed tissue which discharges a considerable amount of pus. Such wounds heal slowly. They are known as *purulent wounds* and their healing as healing by second intention (secunda intentio).

All surgical patients are divided into two groups, according to the nature of the wound process. The first group consists of patients who are operated on under aseptic conditions, and whose postoperative wound heals by first intention. The same group includes patients with accidental wounds which are excised and sutured and which heal without purulence. This is the group

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* The antibiotics are to be chosen after testing the sensitivity of the microbes to them.

of *nonpurulent surgical patients.* The enormous majority of patients in modern surgical institutions belongs to this group.

The patients with accidental infected wounds, the postoperative patients in whom the healing of wounds is complicated by suppuration, constitute the second group, i.e., *purulent surgical patients.*

Healing by first intention. Healing by first intention is a very complex process with a reaction of the whole organism to the injury and a local reaction of the tissues. It is possible only when the edges of the wound contact each other or adhere by suturing.

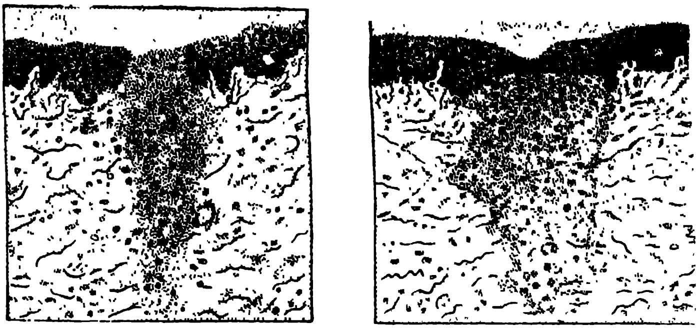


Fig. 197. Healing by first intention

This process begins the moment the hemorrhage has ceased. The fissure between the edges of a wound is filled with lymph and blood which soon coagulates.

The tissues of the wound edges always contain some injured or necrotic tissue cells, red blood cells which have emerged from the vessels, and thrombi in the severed vessels. The process of healing operates as a result of reproduction of the local connective tissue cells and emergence of white blood cells from the vessels (Fig. 197).

In addition to the formation of new cells, the injured blood and tissue cells, clots of fibrin and bacteria which have penetrated into the wound are dissolved and resorbed.

Formation of connective tissue cells is followed by formation of collagenic fibres, which in the end leads to appearance at the site of the wound of new connective tissue with new vessels (capillaries) connecting the edges of the wound. As a result, young connective tissue is formed at the site of the wound. The epithelial cells also regenerate and within 5-7 days the epithelial layer is restored.

The process of healing by first intention is essentially completed within 5-7 days. Subsequently the number of cellular

elements decreases, the number of connective tissue fibres increases, the vessels are partly drained, and the cicatrix changes from pink to white. In general, any tissue —muscles, skin, internal organs, etc.,—heals almost exclusively by forming a connective tissue cicatrix. The healing by first intention is undoubtedly influenced by the general state of the organism. Emaciation and preceding acute diseases, as well as chronic diseases, impede healing.

Healing by second intention. Wherever the edges of a wound are not close to each other (for example, after excision of tissues) and the wound contains necrotic tissue, a voluminous blood clot or foreign bodies (tampons and drains), the wound heals by second intention. In such cases the wound undergoes a series of changes consisting, in the beginning, in a gradual cleansing of the wound from the necrotic decomposition, which is usually accompanied by abundant purulent discharge.

Every wound complicated by an inflammatory purulent process also heals by second intention with a more strongly pronounced general reaction of the organism. However, not all wounds healing by second intention are complicated by purulent infection.

Microscopically the process of healing by second intention operates as follows: the vessels of the edges of the wound dilate, the edges of the wound become red, swollen and moist, the borders between the tissues are smoothed away and newly-formed tissue is observed as soon as the end of the second day. At the same time white blood cells emerge in large numbers from the vessels, young connective tissue cells appear and buds of capillary vessels are formed. The grains of the granulation tissue consist of the small branchings of the capillaries ("buds") with the connective tissue cells surrounding them, white blood cells and other tissue cells. Usually granulation tissue fills the entire cavity of the wound forming a red granular mass by the third or fourth day.

Granulation tissue is thus a temporary integument which somewhat protects the tissues against any extrinsic injuries; it impedes absorption of toxins from the wound. It follows that it is necessary to treat the granulations carefully because any mechanical (during dressing) or chemical (by antiseptic substances) injury to the easily vulnerable granulation tissue opens the unprotected surface of the deeper tissues and fosters the spread of infection. Fluids exude and leukocytes (phagocytes) emerge through the granulation tissue. New branches of vessels appear in the granulations (Fig. 198), connective tissue cells reproduce, and the tissue thus grows and fills the cavity of the wound.

Epithelisation of the wound takes place as follows: the epithelium is reproduced from the edges, adjacent regions, remains of gland ducts and accidentally preserved groups of epithelial

cells, forms separate islets on the granulation tissue, which then merge with the epithelium reproducing from the edges of the wound. The process of healing is generally completed as soon as the surface of the wound is covered with epithelium.

Only very large surfaces of wounds fail to be covered with epithelium and it is necessary to transplant to them skin from other parts of the body. The transplantation is made either with the entire thickness of the skin by preserving a pedicle flap (plastic surgery with a pedicle flap) or by free transplantation of superficial layers of the skin.

Fig. 198. Section of granulations

Simultaneously with the growth of granulation tissue in the wound cicatricial wrinkling of the tissue takes place in the deeper layers, the capillaries are drained and fibres of connective tissue are formed; all this reduces the volume of the tissue and contracts the entire cavity of the wound, accelerating the process of healing. In such cases the lack of tissue is compensated by a cicatrix which is at first pink and then, after draining of the vessels, white. The time it takes a wound to heal depends on a number of conditions. Sometimes the process takes many months. The consecutive wrinkling of the cicatrix takes weeks and even months and may lead to disfigurement, restricted mobility, etc.

Healing under the crust. In superficial injuries to the skin, especially in small abrasions, blood and lymph appear on the surface; they coagulate and dry, producing a dark-brown crust. When the crust falls off, it reveals a surface covered with fresh epithelium. Such healing is called *healing under the crust.*

The same phenomena are observed when a small section of the skin is cauterised, although in such cases the crust consists of coagulated tissue proteins.

Care of wounds. Microbes may gain entrance into the wound during any dressing, even one very carefully made; moreover, every dressing, especially involving a change of tampons, traumatises the wound and disrupts the granulations. After dressings, especially ones not made carefully enough, the patient with a severely infected wound not infrequently develops fever which indicates a new outbreak of infection in the wound. Hence it is clear why surgeons try to change the dressings as infrequently as possible. It is impossible to set definite periods for changing the dressings, because these periods vary with each individual case.

The necessity for changing the dressing is determined by the general condition of the patient, as well as the state of the wound and the dressing. If the dressing has moved or has become soaked, or if the patient runs a fever, it it advisable to change the dressing in order to be able to examine the wound. However, if none of these unfavourable phenomena are observed, the dressing may be left in place for 3-5 days and even longer.

Many patients believe that frequent dressings hasten recovery and insist on daily dressings. These patients must be explained the erroneousness of such views. Lastly, in many cases the uppermost part of the dressing may be changed without touching its layers directly contacting the wound. It is very important to handle the tissues of the wound during dressings delicately. During dressings, especially ones involving a change of tampons, hemorrhages frequently occur from the injured granulations; these are sometimes very minute pinpoint hemorrhages. Infection not infrequently develops at these sites which form entrances for the microbes to the deeper tissues. For this reason the granulations must never be *wiped* or the pus removed by rubbing the wound, etc., during dressing. The tampons must be inserted in wounds carefully without hurting the patient, for which purpose the wound is carefully parted with retractors without pressing on it, jerking or lacerating it. The tampon must always be removed with two forceps by grasping the part of the gauze which is closer to the surface of the wound, in which case the gauze is easily detached. If the gauze does not come off, it should be soaked in hydrogen peroxode, physiologic saline solution, etc.

Whatever the method of treating the wounds, *asepsis plays the most important part.* To protect wounds against infection, it is necessary to use only sterile instruments and dressing material. The fluids used for washing the wounds and the ointments applied to the wounds must also be sterile.

For greatest possible asepsis the dressings must be made only by means of instruments without touching with the hands either the wound or the dressing material. To avoid infecting the hands during the dressings, it is advisable to make the dressings with hands wearing sterile gloves.

After removing the dressing the pus on the skin surrounding the wound is wiped off with cotton balls soaked in benzine or alcohol; the skin must be wiped away from the wound so that no fluid may get into it. To prevent microbes from gaining entrance into the wound during its tamponing, the skin around the wound is painted with iodine tincture and the wound is washed so that the fluid is poured into it without coming in contact with its edges.

If there are any tampons or drains in the wound, their number must be ascertained. If a tampon or drain is missing, it is neces-

sary to make sure whether it has fallen out into the dressing or on the bed, or is still in the wound.

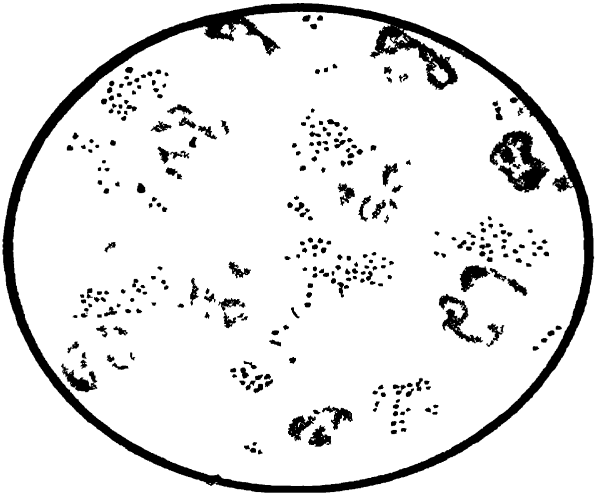
The drain inserted in a wound must not be too long; if it projects from the wound it must be shortened. In cavitary wounds the drains are fastened with a suture. After dressing, the patient must be given rest, and a comfortable position for the injured part must be ensured.

The dressing must be removed carefully so as not to injure the wound. It must be lifted in a manner one turns the pages of a book so that the parts of the dressing lying on the skin do not come in contact with the wound. If the dressing firmly adheres to the wound, it must be moistened with hydrogen peroxide or, after removing the upper layers, be soaked in a warm bath (mainly in cases of wounds on the extremities), after which it may be taken off. When changing a dressing the nurse must watch that pus-containing dressings are thrown into the basin for dressings. If the microbes present in the pus get on the floor, they will be raised with the dust and will infect other wounds. The nurses changing the dressings must be careful not to soil their hands with pus. After the bandaging the dressings containing pus must be burned in special furnaces in the dressing rooms or taken out and burned in special furnaces outside.

Since it is necessary to save time and it is difficult adequately to disinfect the hands, especially since hands soiled in pus cannot be considered clean even after washing for 10-15 minutes, modern dressing rooms practise so-called *instrumental dressing*, i.e., the dressings are made by means of instruments so that neither the wound nor the dressing material is touched by hand. The medical personnel can change many more dressings if they do not touch the patients' wounds or the sterile dressing material with their hands. While removing the dressings, wiping off the pus, cleaning the wounds and applying new dressings, the personnel may use only instruments (forceps), for which purpose it is necessary to have a large number of sterilised instruments. In reception rooms, dispensaries and first aid stations sterile dressing material and boiled instruments should be kept in readiness so that the first dressing may be made immediately upon the patient's arrival without wasting any time on washing the hands, boiling the instruments, etc. If the instruments are prepared beforehand, it is best to leave them in the vessel in which they were boiled and merely pour out the hot water. Since the instruments remain warm after boiling they soon dry and do not rust.

Infection of Wounds. As has already been mentioned, most of the accidental wounds are infected; the microbes may be introduced into wounds by the wounding agent (primary infection). The wounds made by mine and shell splinters are the most in-

TABLE 1



Staphylococci in pus

Streptococci in pus

fected wounds because pieces of clothing, the patient's soiled skin, etc., penetrate into the wounds together with the wounding agent.

Microbes may gain entrance into wounds from the adjacent parts of the skin, the clothing, etc. Such infection is known as secondary infection. Lastly, wounds may be reinfected during dressing. A new infection introduced into a wound in the presence of a previous purulent process in it is very dangerous.

In addition to contamination of the wound, the character of the wound (contused, incised), the virulence of the microbes and, what is particularly important, the condition of the organism in general, and the nervous system in particular, play an important role. In cases of inadequate reactivity of the organism the microbes developing in infected wounds may cause general infection (sepsis, pyemia). The latter is extremely dangerous.

Inflammation. Penetration of bacteria into wounds or tissues and the action of their toxins result in injury to the tissue and the appearance of products of their decomposition.

Tissues can also be destroyed by chemical substances, for example, turpentine, toxic substances, etc., and physical factors (cold, heat, radiant energy).

The organism reacts to the injury to the tissues by an inflammatory process. Outwardly it is manifested in appearance of pain, swelling, redness, fever and disturbance in the function of the affected organ. Microscopic examination of the tissues reveals dilated vessels, a slow blood flow, fluids exuding from the vessels, liberated white blood cells (leukocytes) and division of tissue cells. Thus the changes in the tissues during inflammation consist primarily in disorders of the local blood circulation (acceleration and then deceleration to the point of complete arrest) which is the cause of the redness and local pyrexia of the inflamed part. But, in addition to this, this part of the tissues swells and becomes hard to touch owing to exudation of fluid, emergence of leukocytes and regeneration of the cells of local tissues; this dense swelling observed during the first period of inflammation is called an infiltrate. Phenomena of inflammation are accompanied by pain, not infrequently pulsating pain, and the patient can not use the affected organ. Subsequently, as a result of circulatory disorders in the region of the inflammatory process, thrombosis of small arteries and veins and the action of bacterial toxins on the tissue, degeneration and partial destruction of the cells (necrosis) take place with lysis of some of the destroyed cells. A granulation wall forms around this focus and the dead tissues are thus separated from the living tissues. Pus is formed from the leukocytes, decomposed tissues and exudate from the vessels (Table I); dissolving the tissue, including the skin, the pus makes its way to the exterior.

The biological essence of inflammation was studied by I. Mechnikov who quite correctly explained it as a reaction of the organism to the injury to the tissues. He also described the devouring (phagocytosis) of the microbes by the leukocytes and connective tissue cells (tissue phagocytosis) which develop around the focus of inflammation.

The injury to the tissues (alteration) is followed by their restoration through multiplication of tissue cells (proliferation).

Inflammation is accompanied by considerable biochemical changes in the tissues, the most important of which are increased metabolism attended with pyrexia, increased interstitial pressure in the region of the inflammatory focus, and a change in the reaction of the tissues (increased acidity).

The changes observed during inflammation must not be considered a local reaction of the tissue. They are a local expression or a local manifestation of the general reaction of the organism, including the reaction of the nervous system.

Inflammation is most frequently a manifestation of the struggle of the host against the microorganisms. It therefore stands to reason that its course and outcome depend not only on the microbes, their species, virulence, numbers, etc., but also on the host, its condition and reactivity of its nervous system.

The following reactions of the organism are distinguished: normergic reaction in which the process is most typical with a normal reaction to the infection, and a hyperergic, i.e., intensified reaction with violent general (fever, grave general condition, etc.) or local phenomena (considerable edema, extensive infiltrate, etc.).

Lastly, in weak and emaciated patients, for example those affected with cancer, a hypoergic reaction is not infrequently observed, i.e., the process operates slowly and sluggishly with normal or slightly elevated temperature and minor local manifestations.

If the inflammation does not last long (several days or weeks) it is called acute. But if it persists over a long time (months) it is called chronic. Inflammation does not always end in suppuration. It may also end in resorption of the infiltrate, in which case the redness vanishes, the pain ceases, the tissues assume their normal appearance and the infiltrate gradually disappears. In case of suppuration the infiltrate softens, pus appears and makes its way (if the abscess was not opened in due time surgically) through the skin, and a wound is formed; this wound heals only with formation of a cicatrix. Lastly, in some cases the inflammation may become chronic.

During the inflammatory process changes take place in the patient's nervous system (normal sleep is disturbed and the patient develops insomnia, general indisposition, headaches, irritability etc.).

During inflammation the functions of various organs and systems are disturbed, particularly the function of the intestines, which is manifested in loss of appetite, dry and coated tongue and dyspeptic phenomena.

The clinical phenomena during inflammation are manifested primarily in fever. During inflammation fever takes different forms. The most typical fever for a purulent inflammatory process is one with low temperature in the mornings and a pyrexia in the evenings, the rapid rise in temperature not infrequently being accompanied by chills. The temperature curve during an inflammatory process usually reflects the course of the process and aggravation in the course of the disease (retention of pus, etc.) is manifested in pyrexia, whereas diminution of the inflammatory process and discharge of pus are attended with a drop in temperature. Acceleration of the pulse which usually runs parallel to the course of the disease, diminished appetite, insomnia, sometimes headaches and general jadedness are also observed. In addition to the febrile phenomena, changes in the blood are also characteristic of a purulent inflammation; these changes consist in an increased leukocyte count to 10,000, sometimes up to 20,000-30,000 and higher with a simultaneous appearance of younger forms of leukocytes, as well as a decreased lymphocyte count (so-called shift to the left). During a protracted course a severe purulent inflammation affects the internal organs, i.e., the heart and parenchymatous organs, particularly damaging the kidneys.

Treating Suppurative Wounds. In passing to the treatment of infected suppurative wounds which are observed in most of the accidental and gunshot wounds we must dwell primarily on the general rules of treatment and then deal with various methods of treating wounds.

Treatment of suppurative wounds is aimed: 1) at preventing further development of the infection and, especially, its penetration beyond the wound into the circulatory and lymphatic system so as to preclude general infection and formation of pus pockets between the tissue, which are dangerous to life, and 2) at cleaning and healing the wound as rapidly as possible.

From this point of view, whatever the method of treatment, the wound must necessarily be opened wide and all the pockets and recesses. without exception, in which microbes may be retained and may develop must be eliminated.

To obtain an active general reaction, conditions best favouring healing of the wound must be set up for the wounded, i.e., the latter must be given suitable hygienic surroundings (light, air, etc.) and complete physical and mental rest, particulary rest for the injured organ (confinement to bed, splint dressings, etc.).

Two periods are distinguished in the healing of a wound: the first period of inflammatory swelling, when the organism struggles

against the microbes, and the second period in which the growth of granulations prevails and the wound heals. The methods of treatment vary with the period of healing.

All the methods of wound treatment may be divided into three main groups: physical, chemical and biological.

Physical methods of treating wounds include creation of a continuous outflow of discharges from the wounds into the dressing. With this procedure the pus accumulating in a wound is immediately eliminated into the dressing, which diminishes the absorption from the wound of the toxins and bacteria contained in the pus. This in its turn creates conditions favouring healing of the wound. The principle of rapid elimination of pus from the wound underlies a number of methods of treatment. We shall dwell on some of them.

Introduction of gauze tampons (loosely folded strips of gauze) *into the wound.* Since gauze readily absorbs fluid, it also absorbs the pus which saturates the adjacent parts of the dressing. Since the fluid in the external parts of the dressing evaporates, a continuous flow of pus from the depth of the wound to the exterior is established. But tampons sometimes act like that only during the first 24 hours, after which the gauze becomes clogged up with solid particles of the pus and the tampon ceases to absorb. In such cases the tampon becomes a foreign body in the wound and irritates its granulations, for which reason tampons have to be frequently changed, and this, as has already been mentioned, entails injury to the granulating wound. The granulations are injured less by moist tampons, i.e., soaked, for example, in a 2 per cent sterile soda solution and then wrung out. Application of moist tampons fosters dilution of the pus and its better absorption in cases in which there is not much pus and the latter is very thick.

Dry and moist dressings without tampons are used more extensively. No tampons or drains are introduced into the wound. During dressing the pus is wiped off only around the wound and is not touched inside it. The dressings are changed as rarely as possible (every 3-4 days) and the absorbing material is placed only on top so that it may absorb only the excess pus. The dressings must not adhere to the surrounding skin or else they will cease to absorb the excess pus. It is best to coat the skin around the wound with sterile vaseline. This method produces particularly good results in instances in which there are no severe phenomena of infection in the wound, as well as during the second period of healing, when the wound begins to granulate.

To diminish traumatisation of the wound during dressing, *ointment dressings* are widely used. They are most suitable during the period when the wound has already been cleansed of the necrotic tissue and is in the stage of granulation and epithelisation.

An ointment dressing consists of gauze whose surface contacting the wound is coated with some ointment. An ointment which does not irritate the granulations and is easily sterilised is preferred. Such a dressing is indispensable in application to vast granulating surfaces. If the granulations grow excessively and project above the edges of the surrounding skin, which retards the healing of the wound, an attempt is made to inhibit their growth by coagulating them with silver nitrate solutions.

The absorption is more vigorous if tampons soaked in moisture-attracting solutions, i.e., hypertonic solutions, are introduced into the wound. A sterile 10 per cent common salt solution, a 25 per cent magnesium sulfate solution and a hypertonic glucose solution are used. The use of hypertonic solutions increases secretion of lymph from the wound tissues into the dressing. Such a continuous flow from the wound into the dressing ensures elimination of toxins, facilitates phagocytosis of the microbes, alters the osmotic state of the wound and fosters very rapid disengagement of necrotic tissues. In such cases dry and lifeless wounds soon assume a healthy appearance owing to development of normal granulations.

Drains, i.e., plastic or rubber tubes introduced into the wound, act like tampons. Through drains pus runs into the dressing, and a continuous flow of pus from the wound to the exterior is established. With drains the dressings may be changed less frequently, i.e., every three days or even more rarely. *Keeping drains in wounds near large vessels or in the abdominal cavity for a long time is dangerous* because pressure of the drain may produce a decubitus ulcer or rupture in the wall of the vessel or intestine.

Open treatment of wounds (especially in cases of burns) in which the wounds are protected only against dust by wire grids with gauze is also practised. The pus runs out of the wound, dries around it in the form of crusts, and the wound, under the effect of air, and in some cases sunlight (solar therapy) *dries* vigorously. During the vigorous drying of the wound attention is devoted mainly to control of bacteria and their toxins, to removing them as rapidly as possible from the wound. At the same time the general reaction of the organism, and creation of conditions favouring the development and growth of granulations in the wound are very essential. Vigorous drying of the wound harms the granulations, injures them and hampers their growth, thus retarding the healing of the wound.

Chemical methods of treating wounds are based mainly on the use of *chemical bactericides and disinfectants.*

As a result of administration of potent disinfectants the growth and development of granulations is not infrequently weakened and the healing of the wound retarded. The use of chemical dis-

infectants is therefore restricted. Hydrogen peroxide is used as one of the disinfectants in the treatment of wounds. It is poured deep into the wound to wash out the pus mechanically, which is favoured by formation of foam. Moreover, dissociation of hydrogen peroxide in the wound liberates oxygen, which creates unfavourable conditions for the development of bacteria living in the absence of air (anaerobes). The use of hydrogen peroxide is therefore indicated in cases in which a mixed infection of the wound (including anaerobes) is suspected (infection from the intestines, pus with an unpleasant odour, gaseous infection—see below). In such cases irrigation of the wound with hydrogen peroxide is expedient. Besides hydrogen peroxide, potassium permanganate solutions are used.

In the treatment of wounds dressings soaked in furacilin (1 : 5000) and rivanol (1 : 500-1 : 1000) solutions are used. These solutions do not very greatly affect the tissues of the wound; they merely somewhat retard the growth of granulations. Very good results in treating wounds are produced by chloramine, its solution apparently acting mainly on the injured tissues and creating conditions unfavourable for development of bacteria in wounds.

Treatment with chloramine is particularly effective in cases of fresh wounds in which the infection has not as yet developed, although there are already injured, necrotic tissues in them. A good effect is produced by sulfa drugs which are administered per os in a dose of 1.0 every 4-6 hours and into the wound in a dose of 5.0-10.0, or by a combined method. Sulfa drugs produce the best results in the treatment of fresh wounds or those which can not be treated during the first 6-12 hours, as well as in surgical interventions in infected, purulent wounds (opening pockets, etc.). Sulfonamide preparations should not be administered into suppurative foci and fistulas because in these cases they are useless.

Sulfonamide emulsions are also extensively used. They are poured into the wounds before bandaging or the tampons introduced into wounds are impregnated with them.

Ointment balsamic dressings proposed by Professor A. Vishnevsky are also widely used. They are employed as weak stimuli which improve tissue nutrition.

The ointment consists of xeroform, tar and castor oil.

Rp. Xeroformii 3.0
Ol. Cadini S. Pix liquida 5.0
Ol. Ricini 100.0

In the absence of xeroform the ointment is modified:

Rp. Tinctura jodi gtt. X
Ol. Cadini 5.0
Ol. Ricini 100.0

Biological Methods of Treating Wounds. Physical and chemical methods of treating wounds are aimed against bacteria, but, as has already been mentioned, some methods of treatment, while combating the bacteria, may harm the tissues of the wound.

Unlike those methods, the biological methods of treatment make it possible to create favourable conditions for the organism, under which the bacteria in the wound cannot multiply. This cannot be achieved with the physical and chemical methods of treating wounds. Biological methods are aimed at enhancing the reaction of the organism to the infection or at introducing ready antibodies (treatment with serums) and attenuated cultures of microbes (treatment with vaccines).

Serum treatment, in addition to specific (see below) surgical diseases (tetanus, gaseous infection, etc.), is administered in cases of wounds infected with streptococci and accompanied by phenomena of general purulent infection. Usually the antistreptococcus serum is administered daily in a dose of 50 ml intramuscularly or subcutaneously.

Active immunisation (vaccination) is used for wounds infected with staphylococci, diplococci and other bacteria; usually so-called polyvalent staphylococcic vaccine against different species of staphylococci (available ready-made) is used. The vaccines are administered subcutaneously, the dose being gradually increased. The injections are made every 1-2 days, depending on the temperature, painfulness and redness at the point of the injection.

The vaccine prepared from the patient's pus, the so-called *autovaccine*, is administered similarly.

Treatment with vaccines is particularly indicated in wounds with a sluggish and protracted general infection.

The biological methods of treating wounds also include their treatment with antivirus, bacteriophage and antibiotics which are administered into the tissues surrounding the wound or into its interior during primary treatment. Penicillin is injected in the treatment of infected wounds in the usual doses of 100,000-200,000 u every 3-4 hours intramuscularly. Administration of its solutions into the open wound may also be of some value.

Choice of the method of treating infected wounds. The first period of the injury is characterised by development and spread of the infection and by acute phenomena—hyperemia, exudation and disengagement of necrotic tissues.

During this period it is necessary to give the wound complete rest (immobilisation) and to facilitate the outflow of the discharge (use of hypertonic solutions). Antibiotics and sulfa drugs administered per os and in ointments, chloramine and Vishnevsky's ointment are recommended. This period of treatment requires good care, and a vitamin-rich dairy and vegetable diet.

During the second period of the course of the injury the inflammatory phenomena die down, the wound clears up, covers over with granulations and heals. At this time hypertonic solutions and antiseptics are superfluous. Ointment dressings, gradual mobilisation and a nourishing diet (including meat) are recommended.

Complications During the Healing of Wounds. If a wound becomes infected and the organism does not react adequately enough to eliminate the infection, a purulent process may develop. The spread and development of infection produce a number of complications. *The most dangerous in this respect are the first 10-15 days after penetration of infection into the wound,* but even subsequently, until the wound has completely healed, there is no guarantee that the infection will not spread.

The infection may spread by passing directly to the adjacent organ through interstitial spaces, the lymphatic and circulatory systems. It spreads particularly frequently through intertissular spaces is cases in which the discharge of pus from the wound is rendered difficult (punctured and gunshot wounds) and when it encounters dense tissues (aponeuroses, fascia, etc.) on its way. Such spread of the infection is observed mainly during the first and second weeks after the wound has been sustained and at the end of the period of healing if the entrance to the wound has become narrow and a cavity containing pus has remained deep in the wound.

The spread of infection to the adjacent tissues causes accumulation of pus in the interstitial spaces. The pus often descends by gravity, for example, from the neck into the thoracic cavity, from the pelvis to the thigh, etc. Such penetration of pus is most frequently accompanied by general signs of aggravation of the course of the disease, i. e., pains, swelling in the region of the wound, pyrexia, headaches, sometimes chills and a feeling of general jadedness.

The treatment of such pus pockets consists in opening them wide and sometimes in opening the primary wound and in creating conditions for a free outflow of pus from the wound.

Treating poisoned wounds. Wounds made by bites of poisonous reptiles (snakes) and insects (scorpions), inflicted with poisoned weapons and infected with ptomaine are called poisoned wounds. *First aid in snake bites consists in ligating the extremity above the bite so as to produce a congestion of blood and impede absorption of the poison.* In the region of the bite the blood is pressed out or the poison is aspirated from the wound by a suction cup. Under surgical conditions the wound is excised and the edematous tissues are dissected. The principle measures are: restful position, a potassium permanganate dressing, subcutaneous injection of a potassium permanganate solution and symptomatic treatment.

Wounds complicated by poisonous substances. In wartime double affections are possible, i.e., contamination of the gunshot wound with poisonous substances. The wound contaminated with a poisonous substance can be identified by the characteristic odour and drops on the clothing or skin. Such wounds become quickly inflamed, their circumference sometimes assumes a brown-red hue and their edges very soon necrotise.

Before starting the surgical treatment of such wounds it is necessary to remove the poisonous substance from the skin surrounding the wound and from the wound, i. e., to detoxicate it. The solutions used in such cases depend on the nature of the poisonous substance.

Stable poisonous substances are removed from small sections of the body with the aid of an antichemical packet, after which, inasmuch as the wound is affected with a stable poisonous substance, the dressing is removed and the wound is given primary treatment. If considerable surfaces of the body are besprinkled with liquid poisonous substances or are affected with their vapours, it is necessary to wash the victim with warm water and soap, the whole body being showered, the dressing covered with an oilcloth.

During primary surgical treatment such wounds are not sutured.

CLOSED INJURIES

Contusion. A *contusion* is characterised by injury to the soft tissue and rupture of the small blood vessels, which produce a hemorrhage into the tissues, while the skin remains intact. The causes of contusion differ very widely. They include various blows: (blows with a fist or stick, blows sustained in falling, blows from falling objects, etc.).

In contusions of the superficial tissues a hemorrhage soon appears as a dark-red spot at the point of the contusion; in contusions of deeper tissues the hemorrhage may be discovered only within several days; sometimes the hemorrhage is concealed. If small vessels are injured and the hemorrhage is slight, the blood fills the interstitial spaces; if larger vessels are ruptured, the extravasated blood parts the tissues and forms an accumulation of blood—*extravasation* or *hematoma.* Owing to the injury to a large number of vessels during a contusion, the nutrition of the tissues is disturbed with the result that some of them necrotise.

The main signs of a contusion are: swelling (extravasation) and painfulness of the injured part. The pain in a contusion appears at the moment of injury and persists for some time. Its character and duration vary with the extent of the contusion,

sensitivity of the contused site and the amount of extravasated blood. With considerable extravasation pyrexia is sometimes observed. Contusion of a particularly sensitive region may produce syncope and shock.

In contusions it is necessary, in the first place, to reduce the extravasation and the painfulness. For this purpose the patient must be given rest, the injured part must be placed in an elevated position and cold must be applied to the injured site (ice bag, snow or cold compresses). If the pains are very intense and threaten shock, narcotics (pantopon, morphine) are administered. After the second or third day, when the danger of hemorrhages has passed, hot compresses and warm local baths are administered to accelerate resorption of the hematoma. The dangerous complications following contusions include necrosis of the tissues in the region of the injury and infection of the extravasation. If hematomas suppurate, incisions are made; the subsequent treatment is the same as in purulent processes.

Sprained Ligaments. Sprained ligaments constitute one of the most frequent injuries to the extremities. During more-extensive-than-normal movement in the joint the ligaments of the joint are stretched, the surrounding small blood vessels are partly and sometimes completely ruptured; most frequently an extra-articular and sometimes intra-articular hemorrhage occurs.

The picture of the injury is usually as follows: pain and swelling in the region of the joint which generally retains its normal contours and the regular relationship of the articular ends. Movements in the joints are possible but are painful and limited, the patient being able to use the injured extremity, for example, to stand on the injured leg, move the affected arm, etc.

The hemorrhage becomes visible through the skin only during subsequent days. First aid for sprained ligaments consists in complete rest for the affected joint because movement increases the hemorrhage and aggravates the process. If the ligaments of the leg are sprained, the patient must be put to bed with the leg raised; in cases of sprained ligaments in the arm, the arm must be carried in a sling. Sometimes even a plaster bandage is applied. To reduce the hemorrhage and pains, an ice bag or cold compresses are applied to the site of injury. Heating procedures (hot compresses, baths) and massage are begun on the second day. The ligaments of the injured joints are long disposed to new sprains and the affected joint must therefore be carefully protected.

Dislocations (Luxations). Dislocation is a displacement of one or several bones from their normal position in the joint with the articular surface of one being displaced in relation to the articular surface of the other bone owing to rupture of the joint capsule; the articular surface of the bone frequently emerges through the rupture from the cavity of the joint. If the articular

surfaces are at least in partial contact with each other, the dislocation is known as an incomplete dislocation or a subluxation.

Dislocations are most frequently caused by falls, blows and strong and awkward movements in the joints (so-called *traumatic dislocations* which occur in joints during movements exceeding their normal range).

Pathological dislocations, i.e., dislocations which are caused not by injuries but by a disease in the joint or the articular ends of the bones due to distention of the articular bursa by exudate or destruction of the articular ends of the bones, may produce pictures which are not quite characteristic.

There are also *habitual dislocations*, i.e., dislocations occurring repeatedly in the same joint. In these cases the articular bursas and ligaments are stretched to such an extent that sometimes merely an awkward movement is enough to produce a dislocation. Habitual dislocations constitute a severe affection, because they frequently disable the patient.

Lastly, there are also *congenital dislocations* which are observed for the most part in the hip joint.

According to the time of origin fresh dislocations (during the first day after the injury has been sustained) and chronic dislocations are distinguished; in the latter cases the articular bursa has not infrequently contracted so that reduction of the dislocation is difficult and sometimes absolutely impossible.

Traumatic dislocations produce a characteristic picture owing to which they are usually diagnosed without any difficulty. Only in instances in which dislocations are accompanied by fractures of bones is the picture more complex.

A dislocation is usually characterised by the following signs: sharp pain does not diminish since the moment the injury has been sustained and persists for at least a few hours. Because of the pain the injured favours the extremity, supports it (this is particularly characteristic in dislocations of the arm), and does not allow anybody to touch it. Furthermore, the position of the extremity in the joint is unnatural and very definite for each dislocation, the patient supporting the affected extremity in that position. Thus, during dislocation of the arm forward the patient usually holds the arm flexed in the elbow joint with the elbow abducted from the trunk; during dislocation in the hip joint the affected leg most frequently turns inward. Almost complete immobility in the joint and a fixation of the extremity in the incorrect position are the distinguishing signs of a dislocation.

The configuration of the joint during dislocation is sharply altered. An affected joint considerably differs in shape from a normal joint. In the affected region part of the soft tissues not infrequently sags while the other part protrudes over the dislocated end of the joint (Fig. 199).

The one and only treatment of a traumatic dislocation is reduction. As a rule, a reduction must be performed by a physician. Upon establishing a dislocation it is therefore necessary to summon a physician or deliver the patient to a hospital. As a temporary measure, until the arrival of the physician, cold may be applied to the joint because it somewhat reduces the pain. A patient with dislocations in the joints of the arm may walk to the hospital or be transported in a sitting position; it is best to put his arm in a sling. During dislocations in the lower extremities the patient must be delivered to a medical institution in a recumbent position.

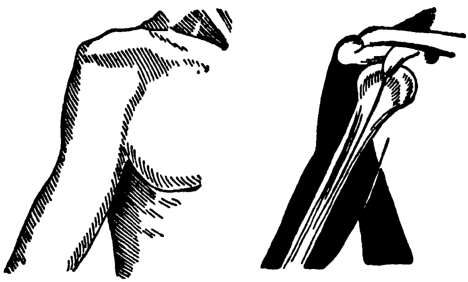


Fig. 199. Dislocation of the shoulder

After reduction of the dislocation an immobilising bandage is made for 7-10 days, and after six or seven days the patient is administered massage and is permitted to perform movements in the joint. As a result of these measures the extravasation is more quickly resorbed and the bursa of the joint is strengthened.

A dislocation is reduced best during the first hours and, in extreme cases, during the first days after the injury hes been sustained. It is therefore recommended that dislocations should be reduced as soon as possible, especially since only a reduction brings the patient relief and alleviates the pain.

If a dislocation is reduced on the second day or later, it is rendered difficult by great muscular tension. To relax the muscles it is therefore not infrequently necessary to administer anesthesia. It is rarely possible to reduce a more than two-week-old dislocation (old dislocation) bloodlessly; it is usually necessary to open the joint and reduce the dislocation surgically. Timely reduction of dislocations ensures complete restoration of the function in the joint, whereas reduction of old dislocations, especially a bloody reduction, results in much poorer mobility in the joints and not infrequently limits the patient's efficiency.

FRACTURES

A breaking of a bone is called a *fracture*. The following injuries to bones are also distinguished: *infractions* (incomplete fractures) and *cracks* which look like fissures running through the bones without changing their shape, i.e., without displacing the fragments.

Congenital fractures, occurring during the child's fetal life as a result of traumas or pathological processes, and *acquired* fractures are distinguished. The latter are divided into traumatic and pathological fractures. Traumatic fractures are fractures of healthy bones caused by external violence.

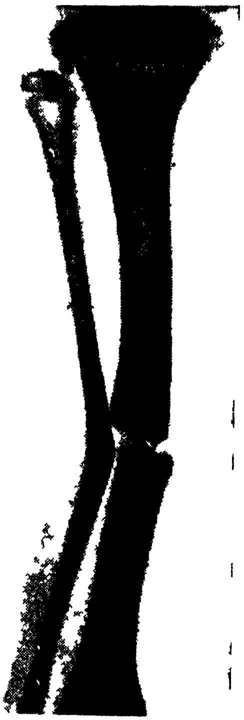


Fig. 200 Transverse fracture

Fig. 201 Oblique fracture

The most frequent fractures are those of the forearm; in the order of frequency, they are followed by fractures of the shin-bones, ribs, clavicles, wrists, upper arms, thighs, feet, the skull and the spine. Traumatic fractures usually result from falls, blows, being run over by vehicles, and injury by moving parts of machines, as well as strong awkward movements.

The mechanisms of injury to bones vary. A fracture occurs when a bone is *bent* beyond the limits of its elasticity, compressed (compression fracture), *severed* by a stretched tendon, *twisted* (torsional fracture) and *crushed* (for example, gunshot fractures). The bone may break at the point of the blow (direct fracture) or at a considerable distance from the blow; for example, during a fall on an extended arm the shock is not infrequently trans-

mitted to the clavicle and the latter is fractured (indirect fracture).

Fractures frequently occur in elderly people because of their greater predisposition to trauma.

Children sustain fewer fractures because of the elasticity of their bones. In old age fractures occur quite frequently because of the fragility of the bones.

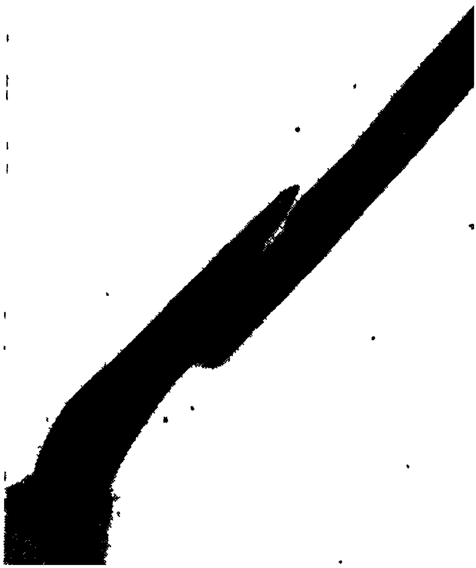


Fig. 202. Spiral fracture

Owing to destruction by some pathological process (tumour, etc.), a bone may become so fragile as to break from an insignificant injury or even without an injury. Such a fracture is known as a *pathologic* fracture.

A bone may break transversely (Fig. 200), obliquely (Fig. 201) or spirally (Fig. 202) (transverse, oblique and spiral fractures); it may also break into separate splinters (comminuted fracture) (Fig. 203). After a fracture the broken ends are in most cases displaced in relation to each other, owing to which the shape of the extremity sharply alters. The displacement is caused, firstly, by the force producing the fracture (especially in direct fractures) and, secondly, the action of the muscles attached to the bones. As a matter of fact, each bone has muscles attached to it with different directions of traction; when the bone is intact,

their actions are mutually balanced (at rest), but during a fracture a muscle pulling in one direction may be attached to one fragment and one pulling in the opposite direction—to the other fragment. It is perfectly clear that after the fracture the fragments of the bones will part under the influence of opposite traction. The fragments may be displaced (Fig. 204) *longitudinally* (*a*), *at an angle* (*b*), *sideways* (*c*), *with separation* of the fragments and with the fragments being driven into each other.

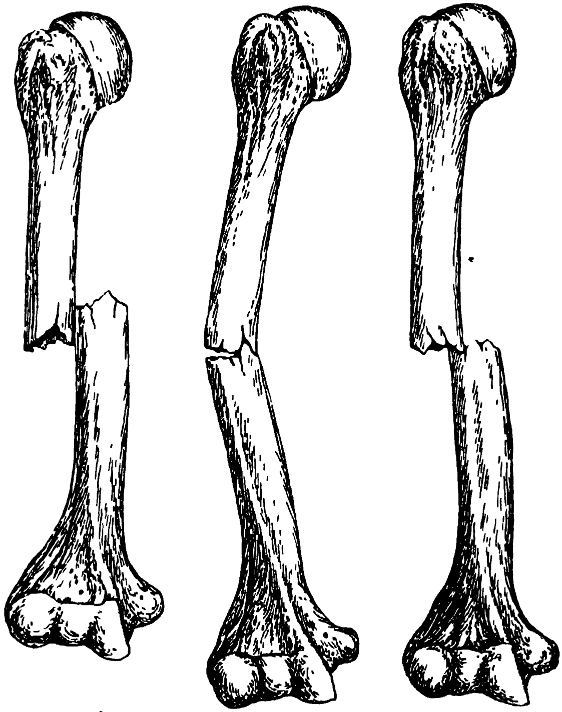
Fractures in which the skin in the region of the fracture is not broken are called *closed* fractures; fractures in which the skin is broken are called *open* or *compound*. Open fractures are much more dangerous than closed ones because the site of the fracture is easily infected through the wound in the skin, which produces a severe local purulent process and sometimes sepsis.

Fig. 203. Gunshot and comminuted fractures

Diagnosis of fractures. Of the general signs of fracture we must note the possibility of development of shock and syncope (depending on the pain stimulation), as well as appearance of pyrexia soon after the fracture has been sustained. *Subjective* and *objective signs* of fractures are distinguished. The former include the pain at the moment the injury is sustained and following it, especially on attempts to move. The pain is constant and increases during jolts along the axis of the extremity; pain may be absent only in pathologic fractures accompanied by disease of the nervous system.

Disturbances in function may be manifested either in limited mobility or complete inability to move the injured extremity. The disturbances in function are negligible only in incomplete fractures.

Objective signs of fractures are: swelling in the region of the fracture, change in the shape of the extremity, change in the direction of its axis (Fig. 205), shortening, ecchymosis and other changes noted during examination. The objective signs also include the data obtained by palpation of the bone, namely, the unnatural (pathologic) mobility at the site of the fracture, protruding fragments and grating (crepitation) of the fragments.



a) b) c)

Fig. 204. Displacement of fragments during fracture: *a*—longitudinally; *b*—at an angle; *c*—sideways

Patients with fractures must be examined very cautiously, since carelessness may inflict suffering and even harm. Elucidation of the mechanism of the injury also helps in diagnosing the fracture. The region of the injury is examined after careful removal and, in cases of considerable pain, after cutting off the clothing. Changes in the shape along the long axis of the bone, irregularities in the position of the extremity, curvatures and swelling not infrequently clearly indicate a fracture. To determine the disturbance in function, the patient is asked to move

the extremity. Lastly, the injured extremity is carefully palpated, measured and compared with the normal extremity.

To establish abnormal mobility and crepitation, the extremity is grasped above and below the point of fracture and is carefully and slowly bent at the assumed site of fracture. A very small movement suffices to establish unnatural mobility which is the most authentic sign of fracture. Crepitation is not always present and no attempts must be made to produce it.

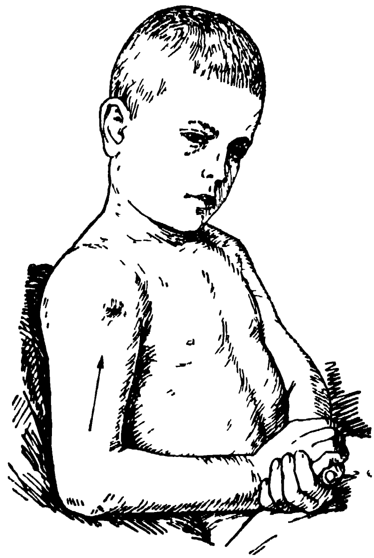


Fig. 205. Change in the axis of the limb in fracture of the humerus

Mobility must be tested only in doubtful cases and carefully enough not to inflict any pain, because careless testing may injure the soft tissues.

Roentgenography of fractures. In all cases of fracture, clear and unlear, it is necessary to make an X-ray examination, i.e., to obtain an X-ray picture. The extremity must be placed for the picture carefully, to avoid movement at the site of the fracture. Soft bandages and cardboard splints do not interfere with the picture, but metal, wooden and plaster splints must be carefully removed before taking the picture.

Pictures are usually made in two mutually perpendicular directions: dorsoventral (direct) and lateral (profile), which are necessary for elucidation of the direction and degree of displacement of the bones. The point of fracture must necessarily be in the centre of the plate. If the pictures are to be made without removing the bandage, it is either necessary to make a mark on the bandage or to indicate precisely of what part of the bone the picture is to be made, for example, the upper, middle or lower third of the femur, tibia or humerus.

An X-ray picture reveals cracks and fragments of bones and offers a precise diagnosis in the most difficult cases, for example, in intra-articular fractures. X-ray pictures are also enormously important for treatment as they make it possible to control the correctness of the position of the fragments after their reposition.

Moreover, with the aid of roentgen control it is possible to obtain data on the union (consolidation) of the fragments and formation of the callus.

Healing of fractures. During the days immediately following the fracture inflammatory phenomena develop at the site of the fracture in the form of serous impregnation of the tissues, local pyrexia, increased morbidity and swelling. General pyrexia may also occur. With proper treatment all this phenomena diminish within 5-7 days and resorption of the extravasation begins. Within 10-15 days the fragments at the site of the fracture are found to be embraced by a spindle-shaped thickening, a so-called *primary callus*, which forms from the periosteal cells, bone marrow, etc. A primary callus unites the ends of the bone as yet weakly, and mobility at the site of fracture persists until the tissue of the callus becomes bony as a result of deposition of calcium salts from the blood. Such a dense callus is already of the nature of a bone. The period of its formation differs according to the size of the bone, general condition and age of the patient, and position of the fragments. This period averages 15 days for small bones and from two and a half to three months for large bones (femur).

Fig. 206. Callus

The callus has an excessive amount of bony tissue (thickening) (Fig. 206); subsequently it decreases in volume, the structure of the thickening resembling that of the injured bone, so that after a long period of time the bone may assume its former appearance.

First aid in fractures. First aid in *closed fractures* consists in primary immobilisation for the purpose of delivering the injured to a medical institution. In most cases no other measures must be taken in administering first aid. Only in cases of a sharp displacement of the fragments with bendings at a right or acute angle, when the protruding fragments threaten to break the skin, it is necessary, by pulling on the extremity, to bring it into the proper position and then produce temporary immobilisation. One of the afore-described splint bandages is best for temporary immobilisation. For protection against pressure by the bandage the extremity is covered with a layer of cotton, especially where

there are bony projections. The simplicity of applying the bandage and accessibility of the necessary materials make a splint bandage indispensable in cases requiring ensurance of temporary immobility, especially during transportation of the patient.

The materials used for splints and the shapes of the splint may differ very widely. The adaptation of different objects

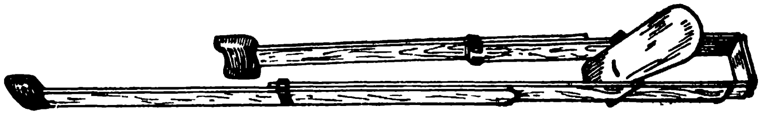


Fig. 207. Dieterikhs' splint

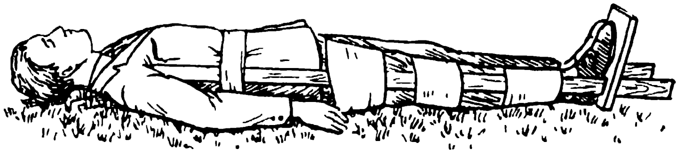


Fig. 208. Dieterikhs' splint applied

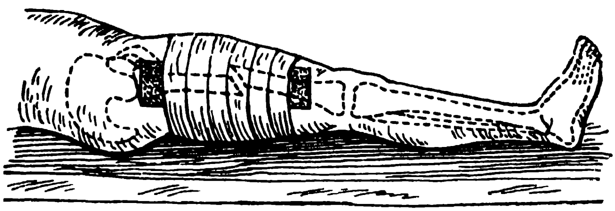


Fig. 209. Insufficiently long splint

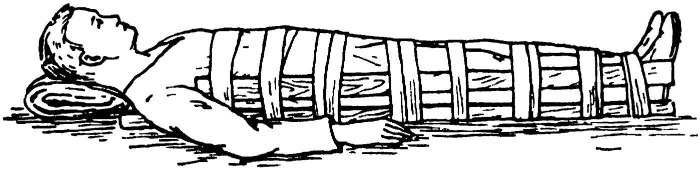


Fig. 210. Sufficiently long thigh splint

(boards, sticks, plywood, bundles of reed, twigs, etc.) for use as splint bandages, such "improvisation of splints" requires certain inventiveness. Special *transportation splints* are very convenient. Wire splints are usually employed during transportation for the upper extremity, the lower third of the shank and for the foot. Dieterikhs' splint is used for the thigh and upper two thirds of the shank. Dieterikhs' splint (Fig. 207) consists of two strips of

wood. The foot is fastened, over the footgear, with a loop (Fig. 208) to the sole-board.

Splint bandages are aimed at immobilising the injured part, easing the pain in the fractured extremity during transportation of the patient and at preventing injury to the soft tissues by the bone fragments. To achieve this, the two joints closest to the injured bone, above and below the fracture, are also immobilised (Figs. 209 and 210). It is necessary to lift the extremity for bandaging, bandage it, lift and transport the patient very carefully, somewhat extend the extremity and, if possible, permit no movement in the region of the fracture.

First aid in open fractures consists in applying an aseptic dressing. The skin around the injury is first painted with iodine tincture. This is followed by application of a splint bandage and immediate delivery of the injured to a hospital. If one of the bone fragments communicates with the exterior, it is not advisable to reduce it because microbes may be carried deep into the wound together with the fragment. The fragment communicating with the exterior is reduced only after appropriate treatment during the operation because the patients are subjected to surgical treatment during the very first hours after they have sustained the injury.

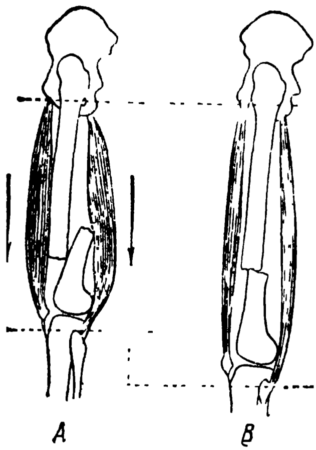


Fig. 211. Effect of muscular traction on displacement

Treatment of Fractures. In some cases the fractures (of the wrist and forearm) are treated in dispensaries, but many patients with fractures, especially of the lower extremity, require hospital treatment.

Treatment of fractures is aimed at achieving a firm union of the bone fragments in the proper position and at retaining the complete function of the extremity.

The main stages in the treatment are: *setting the fragments in the proper position (reposition) and maintaining them in that position until complete union has been achieved.*

The aim of reposition is to place the fragments in such a position in which they may be as close to each other as possible and to restore the anatomical shape of the bone as much as possible.

It should be remembered that displacement of the fragments in fractures is caused by muscular traction of the contracting muscles (Fig. 211,*A*). To eliminate muscular traction which displaces the fragments, the muscles have to be relaxed (Fig. 211, *B*).

To achieve this, the extremity is placed in a position in which the points of attachment of the muscles come closer together, i.e., when the extremity is somewhat flexed in the joints (position of physiological rest). Since it is impossible to place the central fragment in the proper position, the peripheral fragment has to be shifted in the direction in which the central fragment is directed.

Reposition may be effected by pulling the distal part of the extremity, at the same time fixing its proximal end (countertraction). Since muscular tension which increases on the slightest movement usually interferes with such reduction, analgesia is required. Local anesthesia is the most convenient method of producing analgesia during reduction of fractures.

Of course, anesthesia is administered with the most careful observance of the rules of asepsis. It is necessary to sterilise one or two Record syringes, two short and two longer needles, and two forceps. and to prepare 30-50 ml of a 2 per cent novocain solution, several sterile gauze balls and iodine tincture. Novocain is administered with a needle into the focus of the fracture. By mixing with the blood it readily spreads through the focus of the fracture and analgises all the tissues surrounding it. Local analgesia lasts 2-3 hours, which makes it possible not only to set the fragments of the bone and bandage the part, but also to check on the state of the fragments by means of a roentgen examination. If the first reposition is unsatisfactory, the bandage may be removed and the reposition repeated. The fragments of small bones (the epiphysis of the radius, the ankles, tibia) are set by hand.

After reposition the fragments of such bones are very well kept in place by an unpadded plaster bandage with a plaster strip. In fractures of large tubular bones an unpadded plaster bandage with a posterior plaster strip may be applied, if the fragments of the bones are not displaced. In fractures of the long tubular bones with considerable displacement of the fragments reposition may be effected only by means of continuous traction (skeletal traction, see below) with a rather heavy weight—6-8-10 kg. Within a few weeks, when a primary callus has formed on the fragments, the traction may be replaced with a plaster bandage.

Whatever methods are used, *functional treatment* must be provided for. Both the immobilising bandages and traction must permit of movement in as many joints as possible or even in all the joints, while maintaining complete and continuous immobility of the well-set fragments. It should be remembered that in fractures the soft tissues are also injured and the latter must likewise be repaired.

Functional treatment is necessary to improve the blood circulation in the injured extremity and thereby to create favourable conditions for consolidation of the bone, to counteract possible

atrophy of muscular tissue and to reduce the content of calcium in the bone. Skeletal traction and an unpadded plaster bandage constitute the best method of functional treatment. During continuous traction of the extremity, which sets the fragments in the normal position and fixes them, the patient can move the extremity in the joints and tense the muscles, which is quite enough to prevent their atrophy.

During treatment of fractures the following technique of bandaging is the most popular. The bandages are made without padding with the aid of plaster-impregnated strips and circular plaster bandages. Plaster-impregnated strips 8-10 layers thick and cotton or gauze pads to protect bony points (sacrum, crests of the ilia, etc.) are prepared beforehand. The hair on the extremity must not be shaved off or coated with vaseline because the bandage is evenly pasted with the hair and stays better. The bandage should be well modelled. After addition of special devices (stirrup, heel) the bandage enables the patient to use the injured extremity, for example, to walk (Fig. 212). Plaster bandages are used in most of the fractures of the forearm, upper arm, shank, wrist and foot. In fractures of the thigh the method of traction is more frequently used (see Fig. 189).

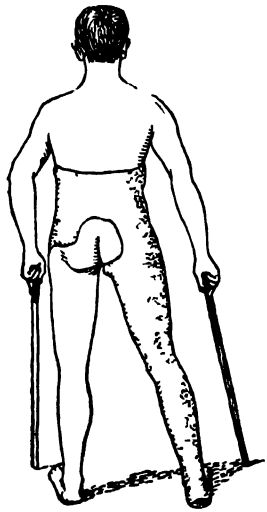


Fig. 212. Plaster bandage with a stirrup

Nurses play an extraordinarily important role in reposition of fragments and in bandaging.

In the first place the duties of a nurse include complete provision with everything that is necessary for reposition and bandaging, preparation and maintenance of the apparatus used in reposition. The nurse must see to it that sterile 1 and 2 per cent novocain solutions are always available, must sterilise the syringes, needles and jars for novocain and the forceps required for anesthesia. She must prepare the plaster bandages, plaster-impregnated strips, cotton, cotton and gauze pads, the knife for cutting the bandages and everything else that is required for bandaging.

During reduction of the fracture the nurse assists the physician; she effects countertraction and accurately executes all physician's orders.

After bandaging the nurse watches the extremity to see if there is no pallor, cyanosis, edema and cold fingers or toes; she ascertains if the patient has any intense pains caused by an excessively tight bandage.

Skeletal traction. Even the best plaster gradually slips off and the force of traction diminishes. Despite heavy weights the force of traction becomes inadequate. Therefore, in a number of cases for traction of the bones of the lower extremities (femur, tibia) the force of traction is applied directly to the bone rather than the soft tissues (skeletal traction).

Thin metal spokes which are passed through the bone by means of a special drill (Fig. 213) are used for such traction. To prevent the spoke from bending as it is passed through the bone, it is

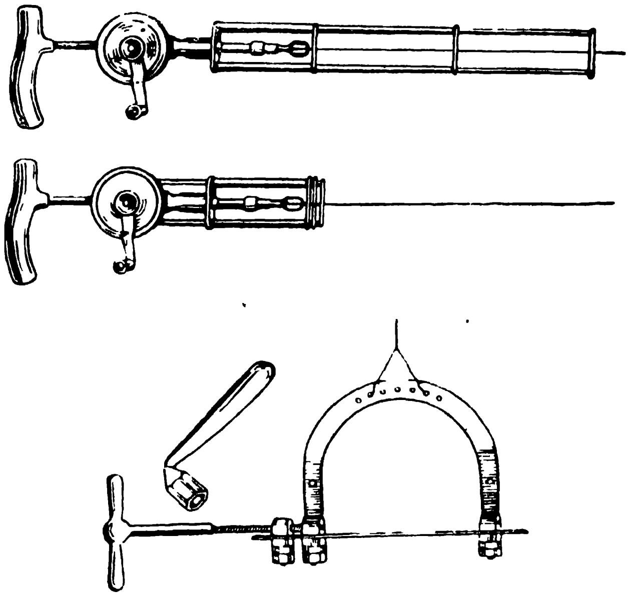


Fig. 213. Drill and crampon for wire skeletal traction

fixed with the aid of a special guide (Fig. 214). When part of the spoke has passed deep into the bone, the guide shortens and continues to fix the spoke in a straight position.

Rules of asepsis must be strictly observed while passing the spoke through a bone. After passing through the bone the spoke is fastened in a special arch (Figs. 213-215).

After one end of the spoke has been fastened in the arch by means of a wrench, its other end is fastened in a screw wrench. By turning the screw wrench the spoke is stretched and fixed in that position in a cramp. Stretching the spoke prevents it from bending and permits the use of considerable weights for traction (8-10 kg for the thigh and 6-8 kg for the shank). For the lower extremity the spokes are passed through the lower end of the femur,

the tuberosity of the tibia (traction of the thigh) or the calcaneal tubercle (traction of the shank). After adjustment of the spoke the extremity is placed in a splint in a position of physiological

Fig 214. Passing the spoke through the tuberosity of the tibia

rest, while a cord with a weight is fastened to the arch, the cord being passed through the pulleys of the splint. Spokes should be removed with observance of all rules of asepsis, i.e., after

Fig. 215 Crampon fastened to the spoke

painting with iodine the part which is outside the bone and which passes through the bone when being removed.

Lastly, to apply traction directly to the bone without piercing the latter, special cramps are used; these cramps pierce the skin

with their pointed parts and fasten to the bone. They are likewise used with observance of all the rules of asepsis.

Skeletal traction also includes traction by the teeth in fractures of the jaws.

Surgical treatment of fractures. Although very many fractures are cured quite satisfactorily with the afore-described methods, in some cases surgical treatment has to be resorted to. These cases include fractures in which the fragments do not contact each other, for example, fractures with displacement of the fragments (fracture of the patella, olecranon), or in which soft tissues are lodged between the fragments.

The method of surgical treatment of fractures is gaining currency. In addition to being used in cases of displaced fragments, nonunion or vicious union of the fragments, it is also employed in fractures of the neck of the femur, open fractures and fractures of the diaphysis of the femur, the upper arm and the bones of the forearm.

Various methods are used in surgical treatment of fractures. For the treatment of fractures of the patella and olecranon it suffices to make a bone suture. For the treatment of fractures of the long tubular bones metal plates, screws and nails are used. In some cases it is necessary to make a free transplantation of bone (union of the ends of fragments by pieces of bone taken from the patient or from another person). Various forms of prosthesis made of different materials are being used of late. Good results are produced by so-called compression osteosynthesis, in which the fragments of bone set in the proper position are fixed and compressed by special devices.

Intramedullary nailing, i.e., joining of bones with metal nails, is gaining currency. The nails are introduced into the medullary canal through a hole drilled in the bone with the aid of a drill, for example, in the region of the greater trochanter for medullary nailing of the femur. Moved along the medullary canal in the parts of the bone above and below the fracture a nail helps to bring the bones closer together and to fit them with precision in the region of the fracture.

It is necessary to choose a metal nail of suitable length and diameter and made of special stainless metal; the rules of asepsis must be strictly observed during the operation.

The subsequent management of patients after medullary nailing and the care of these patients is much simpler than it is with traction or a plaster bandage. The patients begin to move their extremities actively on the second day, and are confined to bed only for a few (2-4) days, after which they are allowed to sit up and subsequently (within 30-40 days) to walk on crutches, stepping on the affected leg.

After formation of a good callus (Fig. 216) the nail is removed.

It is much more complicated to treat *open fractures*. In addition to setting the fragments in the proper position and maintaining them in that position until they have united, it is necessary to prevent the site of the fracture from becoming infected and take measures to control the infection if it has already developed.

Fig. 216. Callus after removal of metal nail

Primary treatment of the wound and the site of the fracture during the first hours after the injury has been sustained produces the best results.

First aid consists in painting the circumference of the wound and, if the wound is small, the wound itself with iodine tincture and applying at first a dry aseptic dressing and, subsequently, an immobilising hardening bandage, a splint bandage or a bandage with traction. If the wound shows no alarming signs (pain, pyrexia, etc.) the bandages are changed very seldom (every 7-10 days).

Fractures with extensive injuries to the soft tissues, fractures in which the fragments communicate with the exterior, and comminuted open fractures require complex therapeutic measures. Fractures of this type are most frequently encountered in gunshot wounds.

In such cases the best results are produced by early surgical treatment which consists in cleansing the site of the fracture, excision of the crushed tissues and removal of foreign bodies and the disengaged fragments which are inadequately supplied with blood. During the operation the bone fragments communicating with the exterior are disinfected and set in the proper position. Aseptic bandages are applied to the wound.

Open fractures aggravated by infection are the most severe. The wound is usually opened and drained. It should be noted that in such cases it is difficult to achieve immobility at the site of the fracture, especially during bandaging, yet any disturbance of immobility during bandaging affects the healing and may aggravate the process. In such cases closed plaster bandages and bandages with traction are the most convenient.

Care of patients with fractures. Patients with fractures require continuous and most attentive watching and care because the danger of complications in such cases is very great.

After fractures, complications may be both general and local. Of the general complications we must dwell on shock which most frequently develops in open fractures during long and painful transportation of the patients. The preventive measures are: a good splint bandage, narcotics, alcohol and careful transportation (for treatment see *Shock*).

Patients who are continuously forced to be in a recumbent position, especially on the back, may develop congestive phenomena in the lungs with subsequent pneumonia. Such complications are most frequently encountered in old and debilitated, mainly cardiac, patients. The measures to prevent these complications are: raising the head end of the bed, breathing exercises, cardiacs and antibiotics.

Owing to the forced position and painfulness of movement, recumbent patients may easily develop bedsores, especially in the region of the sacrum. It is necessary to rub down the skin in the region of the sacrum more frequently with camphor alcohol and to saveguard it against soiling with urine and feces. If possible, the patient should be placed on a rubber ring and carefully watched so that the ring may not become displaced.

Fractures are not infrequently followed by local complications. Blisters with a serous and sometimes sanguineous discharge, predisposed to suppuration, may appear in the region of the injury and must therefore be protected with a sterile dressing. Suppuration of deep hematomas is the most dangerous. It requires surgical intervention. Plaster bandages must be carefully watched, especially during the first 24-48 hours, because very grave complications, including paralyses and gangrene of the extremity, are possible.

To avoid subsequent edemas, it is necessary to place the extremity in an elevated position. In edema, cyanosis and, especially if the toes or fingers grow cold, or in cases of disturbance and disappearance of sensitivity, and pulsation of the arteries the bandage must be immediately cut open. The first signs of an excessively tight bandage are sharp and intractable pains, and the patients must therefore never be administered narcotics after bandaging, while outpatients must be warned to report to a physician immediately upon appearance of pain.

In cases of bandages with traction it is necessary to watch that the extremity does not shift from the position which was imparted to it, that the plaster does not slip off the extremity and the cord off the pulley, that there is no edema below the bandage, etc. All defects of the bandage with traction must be immediately eliminated.

Care of patients with open infected fractures is very complicated. In cases of fenestral and bridged bandages the latter have to be protected from being soiled with pus. In cases of bandages with traction the bandages are not infrequently changed in wards without removing the traction. It is therefore necessary to develop skills of observing the rules of asepsis also under these conditions.

Outcomes of fractures. Concern for the patient does not end after consolidation of the fracture, and the patient must continue to be treated until the proper function of the injured extremity is restored. Limited mobility in the joints, weakness and atrophy of the muscles, and edema of the extremity below the site of the fracture are observed after almost all fractures. These phenomena may persist for one or two months. They are frequently caused by injury to the soft tissues. Faster restoration of function requires proper treatment. In cases in which traction is applied exercises, i.e., movements in adjacent joints started at an early date, foster restoration of functions. To eliminate barykinesia, baths (water and light), massage and exercise, sometimes in special apparatus (mechanotherapy) are used. During the time immediately following consolidation of the fracture the patient must be very careful not to break the as yet insufficiently strong callus. To ease the load on the injured lower extremity, the patient is at first allowed to walk only on crutches. In most cases a timely identified and properly treated closed fracture ends in complete restoration of the function of the injured extremity. However, this does not hold true in all cases. Grave complications leading to invalidism are possible, depending on the site and character of the fracture (certain intra-articular fractures), the degree of injury to the soft tissues, nerves and blood vessels, and other factors.

As a result of improper treatment of a fracture, its untimely identification and late aid, a patient may become an invalid for life.

The prognosis is much graver in cases of open fractures. In these cases the broken bones usually consolidate later and sometimes do not consolidate at all. Moreover, the infection at the site of the fracture may spread, threatening the patient's life; to save the patient's life it is therefore sometimes necessary to amputate the injured extremity.

Complications of fractures. An improperly consolidated fracture with a shortened and, especially, curved extremity may sometimes be corrected by an operation involving dissection of the bone (refracture) with its secondary consolidation in the proper position.

In some cases a callus fails to develop within the usual period of time, the primary callus either completely failing to form or,

having formed, remaining soft. Such slow consolidation may be due to general diseases (tuberculosis, lues, endocrine diseases) and local causes—considerable injuries to the soft tissues, nerves and arteries nourishing the bone, improper position of the fragments and interposition of soft tissues between them.

The treatment of retarded consolidation consists in elimination of its causes, administration of calcium salts per os, vitamins and, sometimes, in surgical intervention.

Sometimes the bones completely fail to become consolidated. This happens most frequently in cases in which soft tissues are lodged between the fragments, a considerable portion of the bone is lost, in open fractures, etc. Abnormal mobility remains at the site of the fracture and sometimes makes it impossible for the patient to use the extremity (false joint).

BURNS, ELECTRIC SHOCK AND FROSTBITE

Burns. Burns are caused by the action of heat (flame, sun, hot liquid, contact with hot metal, etc.), caustics, alkalis and certain drugs (silver nitrate, iodine tincture) on the body.

First aid in burns is aimed at terminating as swiftly as possible the action of heat and at protecting the site of the burn from infection and trauma. The injured must be brought out of the heat zone and his burning clothing must be extinguished either with water or a stream of foam from a fire extinguisher. If such measures are impossible, the injured must be wrapped in a blanket, overcoat, rug, etc. The clothing soaked in kerosene, benzine or napalm must be extinguished only by this method.

Extinction with sand or earth is contraindicated because it infects the burn.

With his clothing on fire the patient must lie down rather than move about. After extinction of the flame, water must be poured on the smouldering parts of the clothing and the latter must be removed. Drops of napalm must not be spread or removed with an unprotected hand. The burning part must be completely immersed in water or compressed with the clothing.

Recurrent combustion of napalm which contains phosphorus is prevented by moist bandages soaked in a 5 per cent blue vitriol solution. The clothing covered with napalm or saturated in hot liquid must be quickly removed without injuring the burnt parts. The clothing adhering to the surface of the burn must not be torn off but rather cut away without touching the surface of the burn.

Administration of pantopon is desirable before removal of the clothing and application of the first dressing. It is also desirable quickly (during the first minutes after the burn has been

sustained) to immerse the burnt part in cold water or pour water from the tap over it for several minutes. or treat it with alcohol (toilet water, alcoholic liquor). In burns caused by caustics the affected surface should be washed with large amounts of water. *In burns produced by quicklime no water must be used;* in these cases the burnt surface of the body must be covered with an oil. In burns made by acids alkaline solutions (soda, calcium or soapy water) are used or the affected part is powdered with chalk, magnesium or tooth powder. In burns caused by alkalis weak acid solutions (acetic, citric, etc.) are used. The victims of burns experience unendurable suffering and, to alleviate the pain in first degree burns, moist dressings containing a potassium permanganate solution, lead water or other wet dressings are applied to the burned surface.

In administering first aid no home remedies, fats or salves must be used.

Four degrees of burns are distinguished.

The *first degree*, the weakest burn, is characterised by an inflammatory process accompanied by local dilation of the blood vessels and slight serous impregnation of the tissues. The skin develops a redness and swelling and becomes painful. After 2-3 days of treatment everything returns to normal and only a dark spot (pigmentation) on the burned part remains.

In *second degree burns* the inflammatory process produces a serous exudation which comes to the foreground and fosters formation of blisters with a serous or jelly-like content on the surface of the reddened and swollen skin. When a blister bursts, it reveals a bright-red, painful, easily vulnerable epithelial layer of the skin tending toward infection. If the burn is not infected, the content of the blisters is resorbed or they burst and dry up within 4-5 days. The epidermis is restored from the edges, as well as from the depth. For some time afterwards the skin is pink, delicate and quite vulnerable, but subsequently it resumes its normal appearance and properties. No cicatrices are formed.

Second degree burns are often aggravated by infection. In such cases healing is retarded, the content of the blisters assumes a purulent appearance, the blisters burst, granulations appear on the bare surface of the epidermis and after healing a whitish or dark superficial cicatrix may remain.

In *third degree burns* a crust is formed on the burned surface because of coagulation of proteins and destruction of tissues. The destruction of tissues may cause circulatory disorders and obstruction of the blood vessels of the skin. In such burns the superficial layers of the skin usually peel off and hang in tatters. Healing takes a long time. After disengagement of the necrotic parts granulations begin to form on the new wound surface (Table II); the granulation takes from several weeks to several months (in ex-

tensive burns). In cases of infection ichoroid or purulent complications, general exhaustion, etc., are possible.

After disengagement of the necrotic tissues epithelisation begins from the edges of the wound and not infrequently forms large cicatrices which contract the surrounding tissues, sometimes making it partly or completely impossible to use the burned part, especially if the cicatrices are located in the region of the joints (Fig. 217) and on the neck. Vast burns may not heal completely, in which cases skin has to be transplanted to cover up such granulating surfaces.

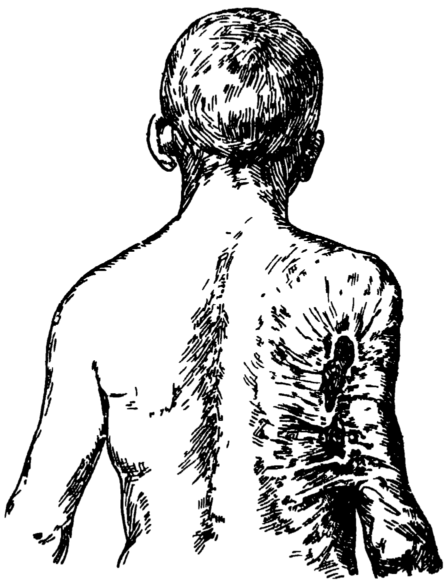


Fig. 217. Scars after burn

A *fourth degree burn*—charring of the tissues under the direct effect of flame or electric current—is also distinguished.

If the injuries from a burn are very extensive or penetrate deep into the tissues, they are dangerous to life. Burns involving one third of the body surface, whatever their degree, are usually followed by grave disorders which not infrequently lead to death. Burns of half the surface of the body are almost always fatal. Burns are particularly dangerous for children, since they may end fatally even if they are not so extensive.

General changes in the organism may develop immediately after the burn has been sustained, owing to stimulation of the nerve endings and reaction of the nervous system (shock) and subsequently (affection of the internal organs—blood, kidneys, central nervous system) as a result of absorption of the toxic products of decomposition from the burnt tissues.

Noninfectious toxicosis appears within 12-72 hours. Excitement or clouded consciousness and then complete loss of consciousness, vomiting, convulsive muscle twitching, pyrexia, rapid pulse, cyanosis, icterus and oliguria are characteristic of noninfectious toxicosis.

Infectious toxicosis develops in cases of infection of the burned surface and is accompanied by pyrexia with considerable fluctuations (higher temperature in the evening), and changes in the blood (leukocytosis and increasing anemia). The patient's condition is aggravated by complications (erysipelas, pneumonia, etc.).

Treatment. First aid to the burned at the place of accident consists in prevention of shock; the victim is administered morphine, kept warm and given hot drinks. The burned part is covered with a sterile sheet or an aseptic bandage. The patient is covered up warmly and is rapidly and carefully delivered to a medical institution (in wartime—to the closest casualty-clearing station), where he is administered an antitetanic serum.

Patients with first degree burns and those with no marked intoxication and only small burned areas, as well as those with second and third degree burns (except burns of the eyes, perineum, the sex organs and feet) are subject to ambulatory treatment. All the other burns are treated in hospitals.

If large numbers of burned patients are admitted to a medical institution they must be assorted according to the urgency and sequence in which they are to be administered aid.

The victims to be administered urgent aid are those who are in a state of shock or have considerable burned areas and may develop shock.

In cases of napalm burns and simultaneous effect of penetrating radiation shock may occur with a smaller area of affection (10 per cent of the body surface).

In the reception room the burned patients, especially with large burned areas, must be given a minimum of sanitary treatment; their clothing and footgear must be removed and the intact parts must be washed. The bandages and sheets applied to the surface of the burns must not be removed.

In hospitals burned patients must be placed in warmer wards where the temperature is 20-25° C. Before primary treatment of the burn the patient is anesthetised, is administered morphine subcutaneously and 20 ml of 0.5 per cent novocain intravenously, or a novocain block, i.e., 100-200 ml of 0.25 per cent novocain is injected into the tissues of the limbs above the site of the burn, the perirenal tissue and into the region of the neck in burns affecting the anterior, lateral and posterior surfaces of the body.

The primary treatment includes administration of 300 ml of plasma and 200 ml of blood. Blood substitutes, i.e., aminopeptide antishock fluid, polyglucin, a 5 per cent glucose solution, physiologic saline solution, etc., may also be used. In cases of extensive burns the patients must receive at least 4-5 litres of fluid and during the first day even more. The patients are given antibiotics, cardiacs (cordiamine, caffeine), and in respiratory disorders—lobelin and cytitone.

Elimination of the shock phenomena must be followed by the primary treatment of the burned surface, which is administered in the operating or dressing rooms. Sterile linens (sheets, gowns, towels), gloves, sterile dressing material and instruments (dressing forceps, 3-4 forceps, 3-5 scissors), syringes with needles,

TABLE II

Third degree burn Mummification of the hand following the burn, demarcation

TABLE III

Carbuncle (top) and furuncle

2-4 scalpels, hemostatic forceps, needles, suturing material, novocain solutions, physiologic saline solution, alcohol, benzine, sterile soap solution, bottles with rubber tubes and everything that is necessary for dermatoplasty is prepared. An oilcloth is spread under the patient so that the fluid may run into the basins placed by his side. Treatment of the burn is begun after removal of the bandages, administration of analgesia or anesthesia and bacteriological inoculation of the flora (to determine its sensitivity to antibiotics). The skin around the burn is treated first; it is washed with benzine or ether with the aid of gauze balls

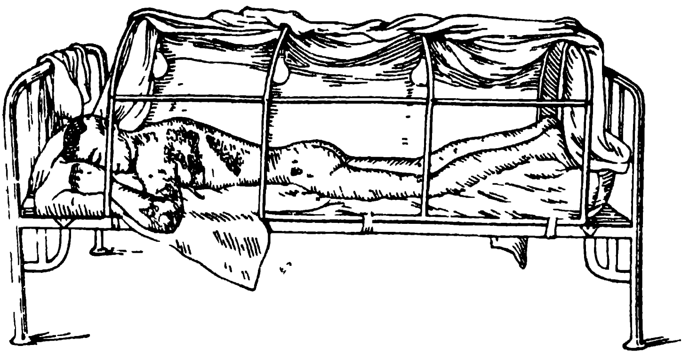


Fig. 218. Open treatment of burn

held with dressing forceps, and then with a soap solution and warm boiled water. A 0.5 per cent ammonia water solution and ethyl alcohol may be used for cleaning the skin. Following this the extraneous material is removed from the affected region and the latter is washed with a physiologic saline solution. The bursted blisters are cut off with scissors and the scraps of epidermis are removed. The contents of the large tense blisters are aspirated with a syringe. Some surgeons remove the blisters completely. The surface of the burn is irrigated with a 0.5 per cent novocain solution and is covered. Dry streptocid, synthomycin emulsion, streptocid ointment or Vishnevsky's salve are used for the bandages.

The dressing is kept on for 10 days.

After primary treatment, or without it, the burn is not infrequently treated by the open method. The open method is used for extensive burns in children, burns on the face, perineum and buttocks in adults, and in cases of infection.

The patient is placed on sterile linens, the region of the burn is left open and a grid covered with a sterile sheet and a blanket on top of the sheet is placed over the bed (Fig. 218). If there is no grid, the sheet may be placed on strips of bandage stretched over

the bed. Electric bulbs are fastened to the grid under the sheet to keep the patient warm. The toilet of the wound is made every day.

Surgical treatment is administered at different periods in the course of third and fourth degree burns; this consists in primary dermatoplasty during the first day after excision of limited parts of the burn and delayed early dermatoplasty between the 7th and 24th day involving excision of necrotic layers and replacement of the defect with skin flaps taken from healthy parts of the body. In cases of very extensive burns the skin for transplantation is taken from volunteer donors or from corpses. Lastly, weeks and even months after the burn has been sustained, large granulating surfaces, as well as cicatrices, may be subjected to surgical treatment (delayed late dermatoplasty).

Care of burns. The open method of treating burns requires particularly attentive, thorough and skilled care. The ward must have an even and higher-than-usual temperature; the patient must be kept warm with the aid of electric bulbs under the grid. The edges of the sheets and blankets covering the grid are carefully tucked under the edges of the mattress. This diminishes the loss of heat and prevents penetration of flies or mosquitoes.

The extremities are placed in a functionally comfortable position and the patient is watched so that he does not alter this position. A sterile sheet must be provided every day. It is necessary to watch the patient carefully so that the surface of the burn may not become infected, especially during defecation and urination. The surface of the burn is carefully attended to every day. If pus accumulates under the crust, the crust is trimmed to facilitate the outflow of the discharge. The skin surrounding the burn is wiped with benzine or alcohol, and the purulent crusts formed on it are removed. Sometimes the patients are prescribed baths into which they must be immersed on sheets.

The bathtub must first be carefully washed with soap and sponge, rinsed with hot water, cleaned with a lysol solution and washed with boiling water again.

Washing the patient in the bathtub on a shield and irrigations with weak potassium permanganate solutions are less dangerous as regards infecting the surface of the burn. After the surface of the patient's body is dried with a sterile sheet the patient is placed under the grid again. If the temperature under the grid rises higher than necessary, one or two bulbs are switched off.

The patient must be given plenty to drink. Grave patients must be administered fluids in enemas, subcutaneously and intravenously (mostly by the drip method).

In cases of extensive burns patients become emaciated and it is therefore very important to provide them with good nutrition, especially sufficient amounts of readily assimilable proteins (dairy diet, delicate grades of meat, etc.). Particularly debilitated pa-

tients have to be turned over on their sides to prevent complications in the lungs. They are also prescribed a diet rich in vitamins and carbohydrates.

If a patient has to be transported, it is advisable to cover the burned parts with a sterile bandage soaked in a potassium permanganate solution or streptocid emulsion, or to apply a paraffin dressing. Since any movement is painful to grave patients, they must not be allowed to move by themselves and must be transported in the least painful position.

In cases of extensive burns, in addition to local treatment by the aforementioned methods, the patient must necessarily be put to bed, kept warm, be administered narcotics (morphine) to alleviate his pains, and fluids (drinking, infusion of physiologic saline solution, enemas, transfusion of blood and blood substitutes), and given cardiacs (camphor, caffeine, digalen, tea and coffee).

It is very important to introduce into the patient's organism large amounts of fluid (up to 4-5 litres per day), especially in cases of extensive burns. In addition to drinking, the patient is administered fluid in rectal drips (physiologic saline solution), subcutaneously and intravenously. The physiologic saline solution may be administered several times per day in doses of 800-1,000 ml.

Moreover, a good effect is produced by intravenous injection of 20 ml of a 30 per cent sodium thiosulfate solution, 50 ml of a 20 per cent sodium chloride solution, a 30 per cent glucose solution and blood transfusion.

In the treatment of small burns on the extremities and trunk in a dispensary the open method is replaced with bandages soaked in a potassium permanganate solution or dressings with powders of sulfonamide preparations, sterile chalk, starch and bismuth.

The surfaces granulating after burns are sometimes treated under salve dressings. During the treatment of burns physiotherapy (sun lamp) is very desirable.

Electric Shock. Extensive utilisation of electricity in industry and agriculture raises the important question of preventing and treating electric shock. Passing through the body, high tension electric currents cause local and general injuries. It is impossible precisely to set the dangerous limit of current tension because it varies with many factors, for example, the humidity of the body. At any rate, a current above 100 v is dangerous and above 500 v almost always fatal.

Electric shock may also be produced by the action of low tension current, i.e., the usual current of urban and rural tension of 120 and 220 v. Most cases of electric shock are caused precisely by currents of the urban grid because the measures of protection used with respect to high tension currents are neglected when it comes to the currents of the urban grid.

Shock results from contact with poorly insulated wires or some other current conductor. Electric shock may occur during the passage of current through the human body or as a result of the action of the heat and light formed during the discharge of high tension current. High tension current also strikes at a distance. During short circuit the harmful effect on a human being who happens to be nearby is produced by the electric arc or sparks which are formed.

Alternating current of up to 15 ma acts only on the nerve endings in the skin, evoking a pain reaction. A current of 15-20 ma stimulates the striated muscles and produces involuntary contractions which are generally characteristic of the action of electric current. In such cases the victim is unable to tear himself away from the wire because of the contraction of his muscles and is, in a manner of speaking, chained to it, thereby prolonging the time of his contact with the current.

A current exceeding 100 ma produces a severe picture of fibrillary contractions of the heart, which cause death. Injury with a current of several amperes entails respiratory arrest.

Two explanations of the mechanism of death caused by electric shock are current today: cardiac arrest produced mainly by appearance of fibrillation due to protracted action of a weak current of the urban or rural grid (120 or 220 v) and respiratory arrest caused by the action, sometimes during a fraction of a second, of high tension current.

The local changes are noticeable mainly in the region of the entrance of the current into and exit from the body; most frequently they reproduce a picture of third degree burn, while in some cases even whole extremities are severed by the current. The patient struck by current immediately loses consciousness. If consciousness returns, the patient is excited, his pulse is rapid and weak, his respiration accelerated; a number of nervous phenomena are observed, namely, convulsions, paralyses and disorders of sensitivity.

It is necessary immediately to discontinue the action of the current on the victim. If possible, it is best to turn off the current at once. It is not always easy to move the victim away from the wires, because he who tries to do it may sustain an electric shock himself. To release the victim from the wires, it is necessary, if possible, to use poor electricity conductors and with their aid to push the victim away from the wires. Rubber gloves, silk fabrics, wool, wooden sticks and dry twigs are poor conductors. It is also necessary to insulate oneself from the ground (put on dry rubber shoes, stand on a dry board).

First aid in electric shock and in injury by lightning must consist primarily in avoiding such harmful measures as, for example, burying the victim in the ground, and must vary with the victim's

condition. In cases of cardiac and respiratory arrest measures to revive the patient must be taken during the very first minutes.

The first thing to do in such cases is to administer artificial respiration. According to literature, there were cases in which a clinical picture of death caused by electric shock seemed to be established and yet the patients were returned to life.

To begin with, the mouth and nose of the victim must be freed of foreign objects. If the teeth are compressed, they must be carefully parted by introducing a spoon or a piece of board between the molars.

The most efficient and widespread method of artificial respiration is Silvester's method.

In cases of injured arms Silvester's method of artificial respiration must not be used. If the ribs are injured, only pulling of the tongue should be resorted to.

Artificial respiration must be administered continuously and for a long period of time. It is most appropriately administered with the aid of a special apparatus resembling bellows developed by V. Negovsky; this apparatus blows air into the lungs.

Simultaneously with administering artificial respiration it is necessary to keep the victim warm, rub him down (preferably with pieces of cloth) and give him to smell ammonia water.

In addition to artificial respiration during apparent death, it is necessary to administer cardiac massage. To do this, the person administering aid places a hand on the region of the victim's heart with fingers pointed towards the head. With the palm of the hand he effects 20-30 vigorous pushes against the part of the chest located under his hand.

Under hospital conditions the fibrillation of the heart muscle may be discontinued and the heart restored to normal activity by a single discharge of electric current from a special device (defibrillator condenser), with a simultaneous intra-arterial blood transfusion.

It is also necessary immediately to protect the site of the burn against infection; as in the other cases of burn, it is necessary to apply an aseptic dressing with alcohol, a 4 per cent potassium permanganate solution, rivanol, streptocid emulsion, etc.

The general measures include administration of glucose and large amounts of fluid, inspiration of oxygen, etc. Treatment of burns produced by electric shock is usually the same as it is in other burns.

In electric shock patients require close watching and thorough care owing to the possibility of sudden death and considerable spread of necrosis in the region of affection.

Frostbite (congelatio) results from prolonged action of extreme cold, although it is sometimes produced even at a temperature of about 0° or somewhat higher. The changes in the tissues during

frostbite are due mainly to thrombosis of the vessels and subsequent disturbance in blood circulation.

Humid cold, a cold, sharp and penetrating wind, tight and humid and long unremoved footgear are factors predisposing to frostbite. The general condition of the organism is very important (healthy and vigorous people can withstand cold longer than weak, emaciated and anemic people). The tips of the fingers and toes, cheeks and tip of the nose are the parts most frequently affected. Four degrees of frostbite are distinguished.

The degree of frostbite is established only during development of reactive phenomena, sometimes within several days after the effect of the cold. During the first, latent period of frostbite, in all its degrees, the skin is pale, cold and sometimes hard (congealed), and its sensitivity is diminished.

In first degree frostbite the vessels sharply contract (spasm), the skin becomes pale and insensitive, and after warming—bluish-red, painful and edematous. First degree frostbite lasts only a few days, but sensitivity to cold and sometimes a bluish coloration of the skin persist.

In second degree frostbite blisters with a serous or turbid content appear on the affected part, the skin around it becoming bluish-red. In this case blood circulation is impaired and the exuding fluid raises the epidermis in the form of blisters.

In third degree frostbite the affected tissues become hard to touch and, when carelessly handled, fragile. After warming up, the blood circulation is deeply disturbed and nutrition of the tissues is affected by occlusion of blood vessels. Disturbances in tissue nutrition are sometimes discovered only within a few days, whereas in the beginning the frostbitten part presents the same appearance as in second degree frostbite (it is blue-brown and covered with blisters and crusts) and the soft tissues necrotise.

In fourth degree frostbite all soft tissues and bones necrotise, and gangrene, often moist, develops (Table IV, top); demarcation and healing proceed slowly. Frostbite is not infrequently accompanied by tetanus.

In frostbite of the lower extremity it is first necessary to remove the footgear, which has to be done carefully to avoid injury to the extremity. If the footgear has congealed, it is best to cut it open.

First aid in frostbite consists primarily in restoration of the blood circulation. Massaging the frostbitten part with the hand wearing a sterile glove is recommended. The massage must be delicate and may be administered more vigorously only after signs of restoration of the blood circulation have appeared. No rubbing down with snow or massaging with dirty hands are allowed.

It is best to rub down the skin at first with a piece of cotton soaked in alcohol and then with a piece of dry cotton. It is recommended to warm up the frostbitten extremities in a bath whose temperature is raised from 18° C to 37° C over a period of 20-30 minutes. The extremity should simultaneously be washed with soap and water to be cleaned from contamination.

After washing, the part should be carefully massaged; active movements and application of 140 proof alcohol to the affected part are recommended.

If the patient applies for aid already during the stage of reactive phenomena, first aid will consist in treatment of the skin in the region of frostbite with alcohol and application of a sterile gauze and cotton dressing.

The patient must be kept warm, protected against repeated exposure to cold and given a prophylactic injection of antitetanic serum.

To protect the patient against infection in second, third and fourth degree frostbite, dry aseptic warming bandages are applied, the blisters are lanced and the disengaged epidermis is removed; during all these procedures the rules of asepsis must be strictly observed. In third and fourth degree frostbite the blisters are removed and the tissues affected with gangrene are painted with iodine tincture.

To improve the blood circulation, a novocain block is produced. To dry the tissues in the region of necrosis, the affected parts are subjected to irradiation by a sun lamp and ultra-high frequency current, and are kept in the open air (dry air baths). To alleviate pain, narcotics and dry air baths are employed; to improve the blood circulation, the affected extremities are raised (suspended). In fourth degree frostbite the necrotic tissues on the limbs are dissected (necrotomy) or excised (necrectomy). As soon as the line of demarcation is established and the blood circulation in the surrounding tissues has improved, the frostbitten organ is amputated. In these cases the wound resulting from amputation not infrequently heals slowly because of sluggish granulation.

Chilblain is caused by protracted exposure to cold, for example, staying in a cold, humid place, long-continued work in cold water (rinsing linen, etc.). It is manifested in appearance of swelling and redness accompanied by slight pain, itching and burning of the fingers and toes (and sometimes of the tip of the nose).

Treatment of chilblain consists in protection against chilling, use of dry heat, warm bath and application of vaseline. The disease usually passes rapidly, but tends to recur.

Prevention of chilblains and frostbite in industry, everyday life and under field conditions consists of a number of measures, including primarily hardening of the organism.

It is very important to protect the clothing from moisture. The clothing and, especially socks, foot-cloths and footgear should be kept dry. Properly fitting waterproof footgear plays a very important part.

In addition to warm clothing, nutrition, moderate doses of alcohol and timely rest are also of some importance.

General freezing occurs in cases in which the organism is no longer capable of producing enough heat to maintain the temperature necessary for life during prolonged exposure to extreme cold.

Death occurs as a result of paralysis of the heart and cerebral anemia. If the temperature in the rectum drops to 20° C, the victim cannot be brought back to life; sometimes death is also possible at a rectal temperature of 30-29° C. Intoxication and general weakening of the organism (loss of blood, starvation, fatigue) predispose to freezing. Age also plays an important part, children and old people freezing more easily.

Freezing starts with chills, sluggishness and an irresistible urge to sleep. The freezing person falls asleep, his members become numb, respiration and cardiac activity weaken. If the freezing person is not awakened and is not given appropriate aid and care he will die in sleep. The victim must be brought into a warm room and measures taken to restore cardiac activity (caffeine, cordiamine, cardiac massage) and respiration (lobelin, artificial respiration).

As in frostbite, administration of aid in general freezing begins with vigorous but careful rubbing down until the numb members become soft and pliable. If there are no signs of life, special care must be exercised not to injure the numb members. Upon appearance of signs of life the patient should be made warm and, if he can drink, should be given hot tea and coffee.

ACUTE PURULENT SURGICAL INFECTIONS

The customary visitors to surgical services are patients with purulent diseases, especially abscesses, digital pulp infection, furuncles, and paronychias.

Purulent infection penetrates, as we already know, through small injuries to the skin (so-called minor traumatism). In such cases a purulent process most frequently develops because the patients at first fail to pay proper attention to their affections and are not given timely and requisite aid. If aid is administered in due time (the wound is painted with iodine tincture and a sterile dressing is applied), i.e., the wound is protected against contamination, purulent diseases develop only in exceptional cases.

Failure to observe the rules of personal hygiene (dirty body, scratches, etc.) favours development of purulent infection.

Penetration of bacteria deep into the tissue does not always result in development of a purulent inflammatory process. A pathological process may develop or fail to develop, depending on the inborn and acquired properties of the organism (age, sex, nutrition, mental state, etc.) which determine its interrelations with the pathogenic factor.

In some cases, under the influence of purulent infection only a *local reaction* in the form of an inflammation of the tissues at the point of entrance of pyogenic bacteria develops. But usually the process does not end there and a *general reaction* manifested in rather marked disturbances throughout the organism develops.

The clinical picture of the disease develops according to the virulence of the microbes which have gained entrance into the organism and the state of the natural defensive powers of the organism. The following purulent diseases are distinguished:

Abscesses. A localised collection of pus in a tissue is called an abscess. Pyogenic microbes penetrate deep into tissues either directly, for example, in punctured wounds, along lymphatic vessels or with the blood stream. At first an inflammatory infiltrate forms in the region of the abscess, pain appears and mobility

is restricted. These are followed by swelling, pyrexia and general feverish phenomena. The infiltrate softens and pus demarcated from the surrounding tissues by a granulation wall forms in the centre of the abscess. Subsequently the process comes close to the surface, the tissues adhere to the skin and the pus may break through to the exterior.

Treatment before the formation of pus during the stage of infiltration consists in applying heat in the form of hot compresses, fomentations, hot water bottles, sulfonamide and penicillin therapy, and ultra-high frequency current. When the infiltrate softens in the centre and a throbbing due to formation of pus is felt (ripening of the abscess), it is necessary to open the abscess surgically and release the pus, or to puncture the abscess, aspirate the pus and administer into the cavity a solution containing 300,000-500,000 u of penicillin.

A scalpel, scissors, anatomical and surgical forceps, Kocher's hemostatic forceps, retractors and a probe must be prepared for the operation.

The cavity remaining after the incision of the abscess represents a purulent wound which is treated according to the usual rules. To prevent further spread of the purulent process, the affected part is placed in a position of rest; with an abscess on the arm the patient must discontinue work; a splint bandage is sometimes desirable; with an abscess on the leg the patient must be put to bed.

Prophylaxis. To prevent the development of an abscess, it is necessary to protect even the slightest injury against infection (paint it with iodine tincture and apply an adhesive plaster or collodion dressing).

All the dressing material saturated with pus must be burned and the objects soiled with pus—disinfected.

Furuncles. Furuncles constitute one of the very widespread purulent diseases of the hair follicles and sebaceous glands (Table III). The disease begins with an appearance of a painful infiltrate in the skin in the form of an inflammatory node differing in size from a pea to a pigeon egg; the skin grows red over the swelling and local pyrexia is observed in the region of the focus. The disease develops over a period of 4-6 days and a purulent blister (exfoliation of the epidermis by pus) is formed at the most protruding part of the swelling. A focus consisting of a necrotic gland with surrounding subcutaneous tissue is found under this blister; the subcutaneous tissue is subsequently discharged together with the pus (the core of the boil). The remaining small cavity fills with granulations and heals.

Treatment. In the beginning of the disease heat is applied; irradiation with a sun lamp and ultra-high frequency current may also be administered. Good results are produced by intramuscular administration of penicillin or by its injection into the subcuta-

neous tissue under the furuncle. The purulent blister is removed with a forceps; the core of the furuncle is also removed with a forceps if it easily disengages from the surrounding tissues. If pus accumulates and is retained deep in the tissues, it is sometimes necessary to make an incision (under local anesthesia with ethyl chloride). The contents of a furuncle must under no circumstances be pressed out with the fingers because the infection may in this case penetrate into the adjacent, unaffected parts of the tissue and, what is most important, into the blood vessels. With an abundance of blood vessels, for example, on the face, this will cause severe complications: thrombophlebitis, septicemia, etc.

During bandaging care must be exercised not to infect the surrounding parts of the skin with pus, for which purpose it is best to apply to them some ointment (zinc paste or 1-2 per cent of white mercuric ointment).

Furuncles usually follow each other in different parts of the body. This disease is called *furunculosis* and is frequently observed in cases of general diseases (diabetes, general exhaustion, anemia, etc.). Furunculosis, especially in debilitated patients, is a serious disease because of its long and stubborn course. In addition to local treatment, it is necessary to treat the main disease (roborants —arsenic preparations, brewer's yeast, etc.).

Prophylaxis. Observance of the rules of personal hygiene (bathing, showering, clean collars) and avoidance of scratching. If pyodermia, blackheads and furuncles appear, they must be treated and injury must be prevented.

Carbuncles. After penetration of pyogenic bacteria under the skin through hair follicles and sebaceous glands the process spreads in depth, if the conditions are unfavourable to the organism, and affects considerable sections of subcutaneous tissue (see Table III).

Inflammatory infiltration is characteristic of a carbuncle. Either resorption of the infiltrate or necrosis of the subcutaneous tissue and then of parts of the skin (cribriform cutaneous necrosis) is possible. The necrotic subcutaneous tissue is dissolved and pus is discharged through the necrotic skin. The affected part is dark-red, dense to the touch, very painful, and may be quite extensive. A furuncle is only sometimes attended with pyrexia and general feverish phenomena, whereas a carbuncle, being a graver disease, is usually accompanied by pyrexia and a feverish state. Carbuncles most frequently develop on the posterior surface of the neck, the back and the small of the back. In the beginning of treatment sulfa drugs and penicillin are administered, physiotherapeutic methods (ultra-high frequency current and phototherapy) are used and novocain with penicillin is injected (Vishnevsky's block), following which multiple or cruciform incisions are made. Subsequent treatment takes very long; moist, saline (10 per cent sterile

common salt solution) dressings are the most effective; after disengagement of the necrotic tissue they are followed by salve dressings which are applied until complete closing of the granulating wound, the latter usually being very extensive because of considerable loss of tissue.

Phlegmons. A *phlegmon* is a suppurative inflammation which is not demarcated from the surrounding tissues and which has spread through the subcutaneous or intermuscular tissue. As in abscesses, the pus dissolves the tissues and approaches the exterior surface; if the process is not interfered with, the pus may break through to the exterior. Together with the pus pieces of necrotic subcutaneous tissue are discharged. In phlegmons the purulent process increasingly tends to spread. The local manifestations include pain, swelling, redness, inability to move the affected part, and local pyrexia. If the process is superficial, a redness appears and gradually passes into the normal coloration of the surrounding integuments. General feverish phenomena are strongly pronounced in phlegmons. The temperature not infrequently rises above 39° C, sharply fluctuates (drops in the morning and rises in the evening), the patient feels generally jaded, loses appetite, and develops headaches and other signs of fever.

For the treatment of phlegmons it is necessary, in the first place, to give the patient complete rest by confining him to bed; a splint bandage is applied to the extremity. Hot compresses are administered; the patient is given sulfa drugs and antibiotic therapy and ultra-high frequency current; the phlegmons are opened with multiple long incisions at an early stage of the disease. The course taken by phlegmons varies. In more severe cases a phlegmon not infrequently produces septicemia and is dangerous to life. The patient must be put to bed and given thorough care. The treatment, both general and local, takes a long time. The dressings must be changed carefully.

Lymphangitis. A spread of infection along the lymphatic system is manifested in a disease of the lymphatic vessels and lymph nodes. *Inflammation of the lymphatic vessels (lymphangitis) is one of the frequent complications of infected wounds, especially during the first weeks following injury,* and of local purulent diseases. Lymphangitis also develops in cases in which the discharge of pus from the wound is hampered, new infection gains entrance into the wound during dressing and during accelerated outflow of lymph, for example as a result of untimely or vigorous movements of the affected organ.

In lymphangitis the local manifestations consist in appearance of longitudinal red lines on the skin along the course of the lymphatic vessels (see Table IV), i.e., inflamed superficial lymphatic vessels which are palpated as dense cords and are painful to touch. Simultaneously the adjacent lymph nodes (regional, for example

inguinal or axillary) become swollen and painful; general phenomena in the form of chills and fever of up to 40° C are also observed.

The *treatment* of lymphangitis consists primarily in elimination of its cause (incision of the abscess, pockets of the wound, etc.) and in giving the affected organ complete rest. Confinement of the patient to bed in lymphangitis of the leg and splint bandages if the disease affects the arm are obligatory. The red lines and the region of the swollen lymph nodes are painted with iodine. Hot compresses and administration of antibiotics are recommended. If pus is retained in the region of the wound, an attempt may be made to remove it (the pockets are opened, the crusts are taken off and absorbent dressings are applied).

Under the influence of the foregoing measures the inflammatory phenomena in the lymphatic vessels usually abate, the temperature drops within 2-3 days, the redness disappears and within a week everything returns to normal. In some cases purulent foci (abscesses) form along the course of the lymphatic vessels; these abscesses are at first treated with hot compresses and then incised.

Prophylaxis. Rest, recumbent position and splinting in all purulent processes. Early surgical treatment of purulent processes; incision of abscesses to diminish absorption of pus.

Lymphadenitis. In purulent processes the infection spreads through the lymphatic vessels and penetrates into the lymph nodes where it is retained. In infected wounds this is very frequently manifested in swelling, enlargement and painfulness of the adjacent lymph nodes. If the disease develops on the arm, the elbow and axillary nodes enlarge; if the disease is on the leg, in the region of the perineum or the anus, the inguinal lymph nodes become enlarged. The infection sometimes gains entrance into the lymph nodes after lymphangitis and sometimes develops spontaneously without any visible inflammatory phenomena in the lymphatic vessels. Not infrequently the enlargement and painfulness of the lymph nodes disappear within 2-3 days because of a limitation of the inflammatory process, but sometimes further development of the process is observed. The painfulness sharply increases, a swelling in the region of the nodes appears, the temperature rises and general feverish phenomena develop. Sometimes the process in the region of the lymph nodes abates, but often the purulence extends from the node to the surrounding cellular tissue. The abscess thus formed is usually opened. Remains of necrotic lymph nodes are found in the depth of the cavity. Treatment of lymphadenitis is the same as that of lymphangitis, i.e., rest for the affected organ, hot compresses and fomentations to the region of the inflamed lymph nodes.

Phlebitis and Thrombophlebitis. The blood vessels constitute another avenue for the spread of purulent infection. Penetration of infection into the blood stream is not infrequently preceded by

an inflammatory disease of the veins (phlebitis) with simultaneous coagulation of the blood in the vein and formation of thrombi (thrombophlebitis).

In thrombophlebitis the local manifestations are painfulness and induration along the course of the veins, the latter being palpable as dense cords painful to touch. If large veins are affected, for example the femoral vein, edema of the extremity and cyanosis develop.

In some cases the process may be arrested and the thrombus is gradually resorbed, but even in these cases the disease lasts several months. After thrombophlebitis the lumen of the vein usually fails to be restored, the vein is obliterated and blood circulation takes place only through collaterals. In other cases the thrombus may be dissolved. One or several abscesses may appear along the course of the affected vein; these abscesses either open spontaneously or are opened by a surgeon. With purulent dissolution of the thrombus (purulent thrombophlebitis) the process may extend with the blood stream and may lead to septicemia.

In addition to thrombophlebitis caused by penetration of infection into the vascular bed, there are also nonpurulent forms of thrombophlebitis (phlebothrombosis) in which a certain part is played by hemostasis in varicose veins, disorders of metabolism and increased blood coagulation, for example, during the postoperative period, in cancer, vascular diseases and general disorders of the cardiovascular function, for example in cardiac failure.

Treatment of thrombophlebitis consists primarily in giving the affected organ complete rest; to improve the conditions for blood outflow the organ must be placed in an elevated position. The patient may sometimes have to be in this position for several months, until the process has completely abated. It should be remembered that in thrombophlebitis any rubdowns and massages are strictly prohibited because they may induce the spread of the purulent process throughout the organism and by carrying a disengaged blood clot in the blood stream may cause obstruction of important arteries (embolism), for example the cerebral or pulmonary arteries.

Leeches are not infrequently used in thrombophlebitis, five or six leeches being repeatedly applied to the extremity. Leeches secrete a special substance—hirudin—which diminishes blood clotting. To prevent the progress of thrombosis by diminishing blood clotting, synthetic anticoagulants (dicoumarin, neodicoumarin, pelentan) are administered in thrombophlebitis. Since complications in the form of hemorrhages are possible during administration of anticoagulants, their use is permissible only with control of blood clotting (tests for prothrombin) and systematic urinalyses.

The blood is tested every third day. If the prothrombin index drops below 50, or erythrocytes appear in the urine and hemorrhages

occur, administration of anticoagulants is discontinued. Sulfa drugs and penicillin therapy are used in cases of infectious thrombophlebitis.

Local *treatment* in thrombophlebitis consists in application of compresses with Vishnevsky's ointment (resorbing action), followed by warm, preferably dry air baths. Physiotherapeutic treatment is resorted to very cautiously and gradually, and in the beginning consists merely of rest.

Thrombophlebitis patients must be strictly confined to bed; moreover, since thrombophlebitis of the lower extremities occurs most frequently, the foot of the bed, especially in the beginning of the disease, must be raised. Failure to stay in bed may gravely complicate the course of thrombophlebitis, i.e., the thrombus may be carried by the blood stream and give rise to embolism in the pulmonary artery. This fatal disease sets in suddenly and develops rapidly. The patients complain of compression and pain in the chest and dyspnea; pallor and cyanosis appear, the cardiac function declines, and death soon ensues.

Prophylaxis. Early exercise and rising during the postoperative period; proper treatment of the varicose veins. To prevent relapses —general invigorating measures for the cardiovascular system, and prevention of venous congestion by wearing an elastic bandage or elastic stocking.

Blood Poisoning (sepsis). Infectious diseases in which toxins and products of tissue decomposition are absorbed into the blood are accompanied by general morbid phenomena: chills, pyrexia, rapid pulse, lack of appetite, jadedness, etc. These phenomena are more strongly pronounced in cases in which the infection is spread through the lymphatic and blood vessels (lymphangitis, lymphadenitis, and thrombophlebitis). But they are manifested particularly intensely with the further spread of the infection, i.e., during so-called *blood poisoning* (sepsis). Such blood poisoning may occur after preliminary intermediate stages (lymphangitis, thrombophlebitis) or directly follow local purulent diseases or infected wounds.

Two forms of blood poisoning are distinguished: one associated with development of multiple abscesses in the body and the other without local abscesses.

In the former form of infection—septicopyemia—the picture of the disease is characterised by high fever of an inconstant type with temporary drops almost to normal, the temperature sharply rising again on appearance of abscesses. Of the other symptoms, chills and profuse perspiration should be noted. The disease is very severe and protracted. Despite all the measures used (incision of the abscesses and general treatment) it frequently ends in death because of general exhaustion of the patient and degeneration of the internal organs (heart, liver, kidneys).

The latter form of blood poisoning—septicemia—is characterised by pyrexia of a more constant type of sharp daily fluctuations (drop in temperature in the morning and rise in the evening), absence of abscesses and a picture of severe poisoning with the toxins produced by bacteria.

Treatment of blood poisoning is very difficult. It is easier to prevent the infection than to control it. It is necessary to open the local focus to diminish the passage of toxins into the circulatory system and, in some cases of grave affections, to excise (amputate) the affected organ. Of medicinal agents, mention must be made of specific serums and vaccines, solutions of silver salts, streptocid, calcium salts, 10 ml of a 40 per cent urotropin solution administered intravenously, cardiacs and stimulants.

In the treatment of blood poisoning it is very important to increase the reactivity and decrease the intoxication of the patient, for which purpose the patient is given large amounts of liquids in the form of intravenous drip infusions of physiologic saline solution, rectal drip and subcutaneous infusions. The patient is administered 2-3 litres of fluid (physiologic saline solution, blood, glucose) by intravenous drip infusion in the course of 24 hours. It is necessary to watch the state of the patient's nervous system, tranquilise the patient and alleviate his pains (narcotics, sedatives).

Antibiotics are the most effective agents in the treatment of blood poisoning. Penicillin is administered intramuscularly in doses of 100,000-200,000 u 4-8 times per day or in the same doses intravenously together with drip blood transfusion. Septicemia patients require very thorough care to prevent a number of serious complications.

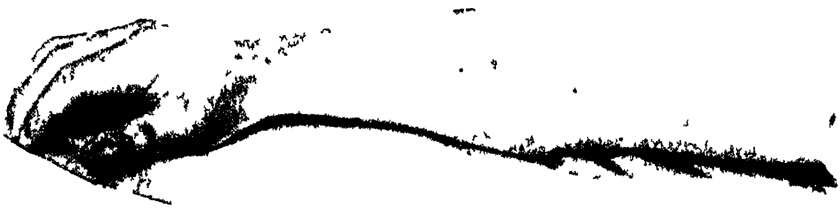
Prophylaxis. The measures for preventing blood poisoning are the same as those for preventing purulent infection in general. They consist in proper and timely aid in injuries, protection of any wound against infection, careful dressing of wounds, and prevention of infection of the wounds during dressing. In addition, proper treatment of local purulent infection and timely surgical intervention also constitute preventive measures, since the microbes found in the tissues may be absorbed into the blood where they may give rise to general infection.

In addition to care of the skin (rubdowns) and changing the linens during profuse perspiration, it is necessary to prevent in such patients the possible development of bedsores.

Special attention must be devoted to the nutrition of septicemia patients; since these patients usually suffer from lack of appetite, they must be provided with easily assimilable proteins and vitamins.

Tetanus. Any wound contaminated with earth may become infected with tetanus bacilli. The disease is caused by the tetanus bacillus found in the earth, especially if it is fertilised with manure.

Gangrene of the feet following fourth degree frostbite



Paronychia, lymphangitis

TABLE V

Severe case of gas gangrene

This extremely grave disease appears several days and even weeks after the injury has been sustained and produces very high mortality. *The first sign of the disease, which attracts the attention, is a locking of the jaws and the patient's inability to open the mouth due to spasmodic contraction of the masticatory muscles.* This is followed by spasm of the back of the neck and the back, which hinder the patient from flexing the neck and trunk. In connection with the spasm of the facial muscles a tense, frozen smile appears on the patient's face. In addition to these tonic spasms of the muscles, the patient develops convulsive attacks because of contractions of all the muscles of the body. As the disease progresses, the convulsions increase and occur on the slightest stimulation by sound, light, etc. During one of these attacks the patient dies of tonic spasm of the respiratory muscles.

Tetanus patients must be given very thorough care. They must be placed in separate rooms and be disturbed as little as possible because any careless movement, shake, or even knock and loud word may cause an attack of convulsions. Before dressing the wound the patients should be given morphine or chloral hydrate. During convulsive attacks the patients must be administered chloral hydrate in enemas or even given narcotics. In addition to narcotics the patients are administered antitetanic serum. In milder cases tetanus is curable, although prophylactic measures produce much better results. *The most important of these is a preventive administration of antitetanic serum.* The serum is administered in all cases of suspicious wounds, i.e., in all wounds contaminated with earth, for example in wounds inflicted by agricultural implements, street and war injuries, etc. Experience has shown that the serum either completely prevents the disease or mitigates its form.

Preliminary administration of an attenuated tetanus toxin (anatoxin) is a still more potent prophylactic method.

Anaerobic Infection. Anaerobic infection, i.e., infection of the wound with bacteria developing in the absence of air (anaerobes), is one of the gravest complications of any wound. The infection is brought into the wound (most frequently as a result of injury with shell splinters) by earth, especially earth fertilised with manure and containing a large amount of anaerobes and their spores. There are very many disease-producing anaerobic bacteria. Of this group of diseases, which includes putrefactive infection, malignant edema, gas phlegmons and gangrene, we shall dwell only on the last two.

Gas Phlegmons and Gas Gangrene. These forms of anaerobic infections are produced by various microorganisms (B. perfringens, B. oedematiens, etc.).

Gas infection has a very short incubation period—from several hours to several days. Sometimes it passes into a latent state and

breaks out only within several months under the influence of an injury or operation.

The changes occurring in the tissues during these diseases are characterised by necrosis and decomposition of the tissues with formation of gases and a weak inflammatory reaction of the surrounding tissues. The subcutaneous tissue and muscles become impregnated with a serous or serosanguineous fluid containing gas bubbles. Under the action of the toxins the hemoglobin disintegrates, the nourishing vessels become obstructed, and the tissues necrotise. If the process develops in the subcutaneous tissue, it resembles that of phlegmons (gas phlegmons). Extension of the process through the deep muscular layer causes progressive putrefactive decomposition of tissues, i.e., the muscles become flabby, look like boiled meat and are coated with a dirty fibrinous film. The disease takes the course of a moist gangrene (gas gangrene).

Anaerobic infection mainly affects the parts of the lower extremity, which are very muscular (buttock, thigh, shank). The first sign of the disease is edema, at first around the wound and then affecting the entire extremity, owing to which the patient begins to complain that the bandage is too tight. The second sign is pain in the region of the wound. Examination of the extremity reveals that it is growing pale and cold; then the skin in the region of the wound turns copper-red, blue-brown or bronze-coloured (Table V); serous blisters appear on the skin. These phenomena quickly spread all through the affected extremity and a serosanguineous fluid with gas bubbles is discharged from the wound. Palpation of the skin in the diseased region produces a sensation of grating (crepitation) which is due to accumulation of gas in the subcutaneous tissue. The presence of gas in the tissues may be established by means of a roentgen picture (method of early diagnosis). The general condition of the patient is very grave from the very outset, a picture of rapidly progressing severe intoxication being observed: pulse—120-160 beats per minute, temperature—39-40° C, skin—pale or icteric, tongue—dry, and consciousness—clouded.

In severe cases the patient dies on the second or third day, whereas in milder cases the process develops mainly in subcutaneous tissue and the patient may recover.

Treatment. Gas infection develops particularly easily in large wounds with disengaged tissues (muscles) deprived of nutrition and in contaminated wounds with large pockets. It is therefore best to prevent it by surgical intervention which consists in earliest possible primary treatment of the wound with excision of the injured and unviable tissues suspected of gas infection, opening widely all pockets and detached tissues, and subsequent open (sutureless) management of the wound. Good results are produced by powdering the wound with white streptocid after primary

treatment and prophylactic administration of antigangrenous serums.

If gas infection has already begun, it is necessary, especially in its rapid forms, to administer vigorous and resolute treatment, i.e., wide multiple incisions of the edematous subcutaneous tissue, extended to normal tissues. The affected parts of muscles are excised and the wound is completely opened because only free access of atmospheric oxygen to the tissues creates unfavourable conditions for the further development of anaerobic microbes. If the process extends to adjacent tissues the surgeon must not hesitate to produce an amputation to save the patient's life, especially in cases of open fractures or injuries to large vessels, which feed the extremity.

In addition to local treatment, therapeutic serums are extensively administered. There are separate serums against each of the four basic anaerobic microbes (B. perfringens, B. oedematiens, Vibrion septique and B. histolyticus). If the nature of the infection has been established bacteriologically, the one serum, specific for the given species of microbes, is administered. If the microbe has not been isolated, the serums against all four causative agents are used (the dose is indicated in the instructions accompanying the serum). Each serum is slowly administered subcutaneously in 300-400 ml of warm physiologic saline solution. The following day or within two days the serum is administered again.

Serums are administered not only for therapeutic purposes, but also as preventives in cases of suspicious wounds, especially wounds sustained in battle. At the front lines serums are administered to all the wounded. In addition to serums, sulfa drugs preparations and antibiotics are used in the treatment of anaerobic infection. In many cases vigorous local surgical treatment and general treatment with the afore-mentioned agents produce a favourable effect.

Owing to the extreme viability of the spores of anaerobes the instruments must be boiled for at least 30 minutes after dressing a gas infection patient.

Prophylaxis. A very important role in preventing anaerobic infection is played by the hygiene of the patient's skin. Early primary treatment of the wounds and administration of antibiotics are the principal measures of preventing gas infection.

Erysipelas. Erysipelas is caused by a streptococcus which also produces purulent processes; moreover, the *infection may be transmitted from one patient to another through the dressing material, hands of the medical personnel, instruments, etc.* In erysipelas the disease begins with prodromal phenomena—general indisposition suddenly followed by excessive chills and a temperature of 40-41°C; vomiting is sometimes observed. Subsequently the temper-

ature either persists on a high level or from time to time drops. Headaches appear and in severe cases the consciousness becomes clouded and delirium develops. Simultaneously with the general phenomena the skin in the region of the wound swells, becomes red and painful, and the patient feels hot. The redness increasingly extends along the skin and may wander all over the body (wandering erysipelas). In addition to redness, suppurating blisters and even necrotic portions often appear on the skin. Sometimes the erysipelatous process is aggravated by a phlegmonous process. For debilitated patients the erysipelatous process is a very serious complication. The disease lasts an average of 6-10 days; in some cases it ends within 24 hours and at times persists for several weeks.

Treatment is general and local. Experience has shown that daily administration of 6.0-8.0 of white streptocid per os or penicillin injections are potent specific agents against erysipelas. The patient must be confined to bed, all pressure or rubbing bandages must be removed and the tissues around the redness must be painted with iodine to prevent the disease from spreading. Irradiation by a sun lamp is effective. The wounds which served as the source of infection must be examined to see if any pus is retained under their edges and if the pus is being well discharged.

Surgical Diphtheria. In relatively rare cases the wound is aggravated by diphtheria, i.e., it becomes infected with the diphtheria bacillus. In these cases greyish-greenish or greyish-yellowish films appear on the surface of the wound; these films firmly adhere to the underlying tissue and their removal gives rise to capillary bleeding. The granulations become sluggish; they are greyish and not infrequently decompose; in severe cases the tissues necrotise. An infiltrate appears along the edges of the wound and the integuments become bright red; the adjacent lymph nodes enlarge. Usually the temperature is not high, but during simultaneous infection with streptococci it may rise to 40°C. The disease is diagnosed mainly on the basis of a bacteriological examination.

Treatment consists in subcutaneous, intramuscular or intravenous administration of antidiphtherial serum in doses of 3,000-8,000 immunising units. In most cases such treatment arrests the inflammatory process, the wound is quickly cleansed and the granulations assume a usual appearance. Local treatment consists in application of iodine tincture or rivanol dressings.

SPECIFIC CHRONIC INFECTIONS

SURGICAL TUBERCULOSIS

If the general resistance of the organism is low, the causative agent of tuberculosis (Koch's bacillus) affects not only the lungs, but may also produce tuberculous diseases of the bones and joints, the skin, lymph nodes, serous cavities (inflammation of the peritoneum and purulent inflammation of the pleura), the kidneys and the urogenital apparatus. In most cases these diseases have to be treated surgically.

The following is the picture of pathology caused by tuberculous affection. When tubercle bacilli gain entrance into a tissue the surrounding tissues react by forming a so-called tubercle consisting of cells which resemble epithelial cells (among these there are giant cells). the capillaries around the tubercle dilate and lymphocytes accumulate. Subsequently the centre of the tubercle necrotises. These tubercles constitute the basic pathoanatomical changes in the tissues in tuberculosis; the merging minutest tubercles look like millet grains, while the accumulations of tubercles surrounded by granulation tissue form the tubercular focus. If the disease develops with a predominant increase in connective tissue, this form is called *fibroid*; the form in which the granulations have increased is known as *fungoid*; the form with serous, fibrous or cellular impregnation is referred to as *exudative*.

Necrosis of the tuberculous tissue may yield *caseous decomposition with subsequent cicatrisation or calcification of the focus.* Dissolution of the caseous masses may form an accumulation of so-called tuberculous pus (cold abscess). *Cold abscesses descending along intermuscular spaces form one of the gravest complications of tuberculosis of bones and joints* because they may come close to the skin and break through the skin, thus leading to formation of fistulas through which secondary purulent infection may easily penetrate. In tuberculosis the bone may also be destroyed without formation of pus (caries sicca).

Simultaneously with local symptoms the patients usually run a fever of up to 37-37.5°C, lose their appetite, grow sluggish, weak,

pale and emaciated, and display other increasing changes in the general condition, i.e., phenomena of general tuberculous intoxication.

Surgical tuberculosis is contracted in the same way as tuberculosis in general, through the respiratory tract, the primary focus forming on the bronchial mucosa, or in the lymph nodes of the mesentery when the infection penetrates through the digestive tract. The bacteria are retained in the lymph nodes and then, with the blood stream, may gain entrance into the bones and joints where they produce the disease.

Tuberculosis of Lymph Nodes. Affection of lymph nodes—lymphadenitis—constitutes about one third of all cases of surgical tuberculosis, the cervical nodes being affected in 90 per cent of the cases. The disease extends from one node to another, the nodes adhere to the surrounding tissues and then to the skin. Nodules, as small as peas, are palpated around the packets of nodes. Dissolution of the nodes forms abscesses and fistulas, but during the tuberculous process the focus may also cicatrise or calcify. Tuberculous lymphadenitis runs a chronic course with a normal or slightly elevated temperature.

Treatment of lymphadenitis boils down to general treatment of tuberculosis, local roentgen therapy and phototherapy; in cases of decomposition of the focus, addition of purulent infection and formation of an abscess in the region of the node it is recommended to open the abscess or to excise it together with the lymph node.

Tuberculosis of Bones and Joints. Tuberculosis most frequently affects the spine (spondylitis) and large joints: the *knee joint* (gonitis) and the *hip joint* (coxitis). The disease usually begins at the articular end of the bone, limited dissolution taking place in the bony substance where cavities filled with granulations and remains of the destroyed bone are formed. The process spreads and breaks into the cavity of the joint in which an exudate or pus accumulates and then breaks out to the exterior producing a fistula. The pressure of the articular ends fosters still greater destruction of the cartilage and bone, while destruction of the ligamentous apparatus may give rise to pathological dislocations and subluxations.

Tuberculosis of bones and joints usually runs a rather typical clinical course. A gradual onset of the disease with vague signs the most characteristic of which are pains, limited mobility and muscular atrophy. The pains may be spontaneous or may increase during movement and work of the affected member; pressure and tapping also produce pain. The disorders of the functions may vary from certain fatigability to complete inability to use the affected extremity because of the painfulness of movement and muscular cramps, and later also because of changes in the liga-

mentous apparatus and destruction of the articular ends. Subsequently, formation of a dense or soft tumour in the joint area, acute atrophy of the bone visible in roentgen pictures, accumulation of exudate in the cavity of the joint, appearance of pus in this cavity and penetration of the pus to the exterior with formation of fistulas and final extreme deformation of the joint are added to the first symptoms.

Uncomplicated cases of tuberculosis of bones and joints last several years. In complicated cases the disease runs a very protracted course; not infrequently the disease seems to be cured, but new aggravations of the process follow. The outcome may be unfavourable due to the general spread of tuberculosis and exhaustion in cases of a prolonged and severe local process; a more favourable outcome is also observed, although cases with grave anatomical and functional disorders are more frequent.

Prophylaxis of Surgical Tuberculosis. Since surgical forms of tuberculosis occur frequently, especially in childhood, prophylactic measures are necessary, especially measures for preventing general tuberculosis. These measures are extensively carried out in the Soviet Union. They are described in detail in textbooks of internal diseases. The special prophylactic measures with respect to tuberculosis of bones consist in early diagnosis of tuberculosis, placement of tuberculous patients in special institutions and sanatoriums for consumptives, accurate dispensary records of tuberculous patients and long-continued observation of the patients during remission of the process.

Treating Tuberculosis of Bones and Joints. In tuberculosis of bones and joints early diagnosis and treatment of the disease are enormously important. Early treatment may reduce the duration of the process and prevent considerable destruction of the bones and joints, and the functional changes which cripple and incapacitate the patients.

The treatment of surgical tuberculosis must be general and local. General treatment is discussed in detail in textbooks of internal diseases. It boils down basically to improving the patient's sanitary and hygienic conditions, better nutrition, treatment with fresh air and sunlight, phototherapy, general roborant treatment, administration of streptomycin and para-aminosalicylic acid. In the U.S.S.R. control of tuberculosis is very effective. Improved living standards, general sanitation of the working and living conditions, improved public services and amenities, better public catering, extensive dispensary service, etc., have considerably reduced the incidence of tuberculosis.

Special institutions are more suitable for *general treatment* of tuberculosis; tuberculous patients may be placed in general surgical institutions only in cases of extreme emergency and only for a short time.

The aim of local treatment is to let the affected joint rest by immobilisation, which is achieved with the aid of *immobilising bandages or traction.* Moreover, traction is very important for controlling muscular cramps which put the extremities into incorrect positions and cause increased mutual pressure of the articular ends.

The advantage of traction consists in the possibility of observing the extremity, administering additional treatment (phototherapy and roentgen therapy), eliminating the cramps, etc. Its disadvantage consists in the fact that the patient is bedridden for a long time, which requires suitable surroundings, i.e., placement of the patient in a sanatorium.

The patients, adults as well as children, administered traction for tuberculosis of the joints require special care. In addition to general care and measures for preventing bedsores, it is necessary frequently to ventilate the room and take the patients outdoors in their beds; special attention must also be devoted to nutrition.

The medical personnel must see to it that the traction is properly applied and that no complications are produced by the pressure of the cuff or bracelet on the tissues.

In tuberculosis of bones and joints plaster bandages are applied to the affected part of the limb so that they cover, in addition to the affected joint, also two adjacent joints to ensure complete rest for the affected joint. The bandage is applied during traction of the extremity. In cases of tonic spasm of the muscles this should be done under anesthesia, when the spasm has diminished and the extremity has become extended or after preliminary extension of the extremity by means of traction. However, the limb must not be extended by force because this may aggravate the process. A plaster bandage is applied for 3-5 weeks after which it must be replaced by a new one. In such cases the bandages are changed many times until the part has completely healed, an increasingly more correct position being imparted to the extremity each time the bandage is changed.

In addition to plaster bandages, plaster splints and casts, as well as crutches and plaster-splint apparatus are also used.

If fistulas have formed in tuberculosis of bones and joints, *careful dressings are required* to avoid secondary purulent infection which aggravates the course of the disease and worsens the prognosis. An iodoform emulsion is sometimes administered into the fistulas through a cannula; the infected sinuses are widened and opened surgically.

In tuberculosis of bones and joints *surgical treatment* is administered quite frequently when other methods have *failed,* especially in old age or in cases in which there are such changes in the extremities, which, after remission of the process, make them unfit for work (severe contractures, subluxations). All surgical inter-

ventions are divided, according to P. Kornev, into three groups: radical, therapeutic-supportive and corrective. The radical interventions include necrectomies—excision of periarticular foci (radical prophylactic operation), excision of extra-articular foci, economic and extended resections of joints and amputations.

Therapeutic-supportive interventions include osteoplastic fixations of the spine and joints, excision and draining of abscesses.

The corrective operations include corrections of defective positions by transection of tendons and bones, plastic operations on joints, etc. The operations most frequently performed consist of excision of the focus and economic resection of the joint; extended resection subsequently results in complete immobility of the joint (ankylosis).

After operations for tuberculosis of bones and joints, the surgical nursing of the patients includes, in addition to all the measures mentioned above, a number of special features according to the localisation and extent of the process and on the character of the particular operation.

In all these cases we are dealing with debilitated patients who have to be kept in bed and who need plaster bandages applied for long periods of time; this necessitates measures aimed at building up the general health (antibiotics, diet, fresh air, phototherapy) and preventing complications which may result from long-continued application of the plaster bandages (muscular atrophy, limited mobility in the joints, etc.).

SYPHILITIC AFFECTIONS OF BONES AND JOINTS

In syphilis the bony system is most frequently affected during the tertiary period, whereas lesions of the joints also occur during the secondary period. Lesions of the bones begin with periostitis. Very often the process also involves the superficial layers of the bone; in such cases not only the periosteum, but also the bone is affected. Affection of bony tissue to the point of its partial necrosis is observed on the one hand, while the bony tissue grows around it, the bone sometimes attaining elephantine density, on the other hand. This is particularly marked in congenital syphilis when the anterior surfaces of the tibia become convex and look like scabbards.

Syphilitic periostitis is most frequently observed on the anterior surface of the tibia, the bones of the cranium and on the clavicles. Periostitis sometimes results in suppuration; subsequently long unhealing fistulas or ulcers which heal with white radial cicatrices are formed; in some cases the bone grows dense without purulent phenomena. The treatment is general—antisyphilitic; local treatment consists in dressing the ulcers.

Syphilitic lesions of joints produce considerable serous exudates into the joints. During the tertiary period deeper lesions of the bones with destruction of the joints are observed. Considerable deformation of the joints, but slight disorders of the functions are characteristic of the disease. The treatment is also specific.

ACTINOMYCOSIS

Actinomycosis is caused by a ray fungus which in the tissues of the host forms characteristic accumulations of the fungus, clubbed at the distal ends and arranged in rays (hence, the name "ray fungus").

The fungus is found on cereals, on awns of ears, especially barley, and is inhaled by persons who come in contact with cereals, while processing grain or chewing raw grain.

In the oral cavity the fungus may nestle in carious teeth as a saprophyte, whence it penetrates for the second time into inflammatory foci or lesions. If the fungus gains entrance into the tissues, an inflammatory process with a dense ligneous infiltrate develops; foci of softening, small cavities with decomposition and fistulas appear in the infiltrate (Table VIII). In the lungs actinomycosis produces a picture of an abscess, in the intestines —nodes and ulcers which resemble tuberculosis or cancer.

Dense granules are sometimes observed in the pus during actinomycosis; these granules can be seen with the naked eye.

Actinomycosis is most frequently localised in the oral cavity, on the neck, in the lungs and in the cecum.

The diagnosis is confirmed by a microscopical analysis of the pus or the granulations.

Treatment of actinomycosis consists in administration of actinolysates, antibiotics and blood transfusions. Much inferior results are produced even by long and persistent administration of potassium iodide in doses of up to 2.0-6.0 per day and roentgen irradiation. Surgical treatment consists in excision of the infiltrate and even of the affected organ or in opening of the foci and curettage of the fistulas.

LOCAL CIRCULATORY DISORDERS

Pathological states may give rise to general and local circulatory disorders. We can refer to circulatory disorders as local only conditionally, since they are closely connected with the general state of circulation.

Local circulatory disorders may in their turn affect the circulation of the whole organism.

Arterial and Venous Hyperemia. *Arterial* hyperemia develops against the background of dilated arteries of an organ and an accelerated blood flow through these vessels and occurs in disorders of vascular innervation (stimulation of the vasodilator nerves or paralysis of the vasoconstrictor nerves), thermal, mechanical and chemical stimulation of vessels, following bleeding (postanemic hyperemia) and during inflammatory processes. In arterial hyperemia pulsation, redness, heat, elevated arterial pressure and increased glandular function are observed, the permeability of the vessels increases and the fluid part of the blood exudes through their walls.

Venous (congestive) hyperemia occurs in cases in which the outflow of blood is rendered difficult by local compression or occlusion of a vein, as well as in disorders of the cardiac function. Cyanotic appearance of an organ, disorders of its nutrition, atrophy of the tissue of the organ, edema and development of its interstitial tissue, are characteristic of venous hyperemia.

Stasis. Total arrest of the blood flow in vessels is known as stasis. Stasis may develop in the lower parts of the body during cardiac decompensation (pulmonary hypostasis of grave cardiac patients).

Collateral blood circulation. If the flow of blood through a vessel ceases because of obstruction of its lumen (thrombus, bandage), the blood runs along collateral vessels (anastomoses); such blood circulation is called collateral or roundabout. The small vessels which receive the blood that formerly flowed through a main trunk become dilated. This causes collateral hyperemia (Fig. 219). Collateral blood circulation is very important; its

development depends on the presence of anastomoses, blood pressure and the rapidity with which the lumen of the vessel is obstructed. The more slowly a vessel is obstructed, the better collateral circulation develops.

Local Anemia (ischemia). Insufficient flow of arterial blood to an organ gives rise to anemia of the organ. Anemia is particularly acute when the flow of the blood ceases altogether. Ische-

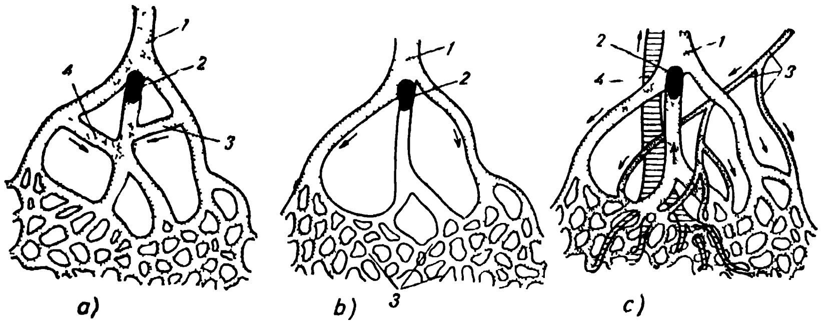


Fig. 219. Diagram of collateral blood circulation
1—major vessel, 2—embolus, 3 and 4—collaterals a—diagram of sufficient collaterals, b—diagram of terminal arteries, c—insufficiency of collaterals during hemorrhagic infarction

mia results from compression of a vessel, narrowing of its lumen by sclerosis, obstruction by a particle brought by the blood stream (embolus) and from tonic spasm of a vessel.

The consequences of local anemia depend on the size of the obstructed or constricted vessel, the rapidity of its onset, the duration of the affection and the sensitivity of the affected tissues to ischemia.

Infarct. Sections of necrosis due to occlusion of small arteries in certain organs are known as infarcts. Ischemic infarcts are called white, whereas infarcts accompanied by overfilling of the capillaries of the organ with blood are known as red or hemorrhagic infarcts. They develop mainly in the lungs and in the heart muscle. The infarct may be resorbed and produce a cicatrix, or in case of added infection (purulent dissolution) may develop into an abscess.

Thrombosis. Coagulation of the blood and obstruction of part of a vessel with the blood clot that has formed by the coagulation is called thrombosis, while the blood clot adhering to the wall of the vessel and obstructing its lumen is known as a thrombus. A thrombus may consist mainly of red blood cells (red thrombus) or of fibrin, leukocytes and blood platelets (white thrombus). If white and red sections alternate, the thrombus is referred to as a mixed thrombus.

A thrombus arises as a result of changes in the quality of the blood, disturbances in its flow and alterations in the vascular wall. Sometimes thrombi obstruct the lumen of a vessel completely (obstructing thrombi), sometimes—partly (lateral thrombi). A thrombus may undergo septic dissolution or may be penetrated by connective tissue (organisation of the thrombus). Formation of channels lined with endothelium is also possible in a thrombus; in such cases the blood circulation is partly restored through the thrombus (canalisation of the thrombus).

Detachment of a thrombus or its parts and their transportation by the blood stream cause embolism.

Embolism and Metastasis. Transportation of any particles (emboli) by the blood stream and their lodgement in vessels with lumens smaller than the emboli are called an embolism. Particles of a thrombus, clusters of bacteria, air which has gained entrance into the vessel as a result of injury to large veins (air embolism) and particles of fat (fat embolism) may become emboli.

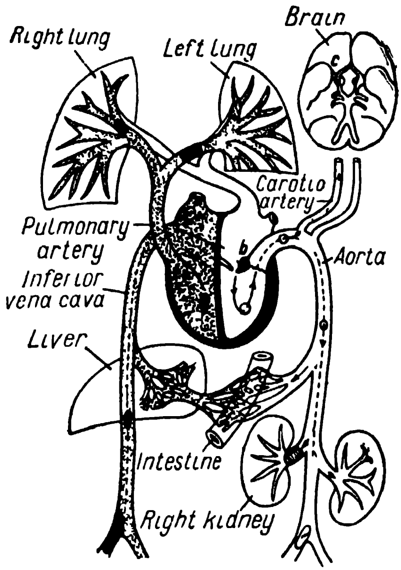


Fig. 220. Diagram showing direction of emboli

Emboli move with the blood stream, gaining entrance from the venous system through the right heart into the pulmonary artery and the lung (Fig. 220). The emboli formed in the left half of the heart pass into the arterial system and are carried into the arteries of the brain, heart, internal organs and extremities.

The development of a pathological process by transportation of pathogenic agents in the blood stream or lymph from one section of the body to another is called a metastasis.

NECROSIS

Death of sections of tissues or organs during the organism's lifetime is known as *necrosis*. Necrosis may be a result of a direct destructive effect on the tissues, for example, coagulation of tissue proteins, destruction of tissues by strong acids, etc. Necrosis caused by disorders of the blood circulation and disturbance in tissue nutrition is often observed. Disorders of the blood cir-

culation may be due to local injury to vessels caused by contusion, frostbite, vascular spasm produced by the vasoconstrictor nerves, or may be the result of systemic disease—vascular changes, for example, in atherosclerosis. Necrosis is also observed in cases in which the trophic innervation of some region has been disturbed during various diseases and lesions of the nervous system (for example bedsores during injuries to the spinal cord, perforating ulcer of the foot in injuries to the nerves of the legs, etc.).

Of the various forms of necrosis we shall dwell on the form caused by injury to the tissues. This form most frequently occurs as a result of circulatory disorders caused by injury, rupture, compression and torsion of vessels. Similar results may be produced by ligation of the vessels of some organ or part of the body, if no collateral circulation develops through the extended communications between the other vessels (through anastomoses).

Necrosis may be a result of arrest of arterial circulation and, more rarely, of disorders of the venous outflow. Thrombosis and embolism may also lead to necrosis.

Gangrene. Embolism and occlusion of vessels may give rise to necrosis of a part nourished by the given artery, and in case of occlusion of a major artery nourishing an entire extremity—necrosis of the extremity (gangrene). In thrombosis blood circulation is arrested more slowly than in embolism. This situation favours development of collateral circulation and gangrene develops less frequently. If a large artery has been occluded by an embolus, there is usually not enough time for collateral circulation to develop and necrosis proceeds very rapidly and violently (within a few hours). An enfeebled and exhausted organism is more predisposed to gangrene.

Circulatory disorders are not infrequent during changes in the walls of blood vessels (atherosclerosis) in old age (senile gangrene), but necrosis is also observed at a younger age in vascular diseases (obliterating endarteritis or spontaneous gangrene). This disease results from constriction of the vascular lumen caused by spasm and then thickening of its inner coat until the lumen is completely occluded.

Gangrene begins with pallor of the integuments, disorders and loss of sensitivity of the tissues, and changes in the colouring of the skin (marbleisation, darkening). Subsequently a picture of mortification develops.

In some cases the tissues quickly dry up because of evaporation of the fluid (dry gangrene); owing to decomposition of hemoglobin the colour of the skin changes, becoming brown and then black. The tissues become dense and hard (mummification).

In other cases, when evaporation from the surface is rendered difficult or the tissues have developed edema, gangrene runs a moist course. Such gangrene is accompanied by putrefactive

infection of the tissues. The tissues decompose and dirty-red and grey spots, lines and blisters filled with a strongly smelling dirty substance appear on the skin. The process may spread and end lethally, the patient dying as a result of septicemia. Most frequently, however, the dead tissues become separated from the living tissues; this is known as *demarcation*, and the line which separates the dead tissues from the living ones is called the *line of demarcation* (see Table IV). A granulation wall and a fissure separating the living tissues from the dead ones are formed on the borders of the living tissues; the dead tissues may become completely detached and sometimes fall off within a few days or even months (bones). After separation of the dead tissues the wound turns out to be lined with granulations and begins to heal.

Treatment of gangrene consists in eliminating its cause, and in moist, more dangerous form—in measures aimed at drying the necrotic tissues and their protection against secondary infection (strictest cleanliness). For this purpose dry aseptic absorbent dressings are used.

In cases of superficial necrosis the separation of the necrotic section is awaited and then the wound is treated according to the general rules for treating granulating wounds. In cases of dry gangrene of extremities the affected extremity is amputated after formation of the line of demarcation. In cases of moist gangrene threatening septicemia amputation not infrequently has to be resorted to. During the incipient stages of spontaneous gangrene the treatment is physiotherapeutic and medicinal.

Narcotics (morphine) must be administered to gangrene patients very cautiously because the pains not infrequently persist for a very long time, the patients growing habituated to narcotics and likely to become narcomaniacs.

Bedsores (decubitus). Bedsores, i.e., portions of necrotic tissue formed in places of prolonged compression of the skin and subsequently producing ulcers—superficial or deep (penetrating to the bone) may serve as an example of gangrene. Bedsores are divided into simple and gangrenous, dry or with considerable discharge of a purulent and putrefactive character. Bedsores result from long lying in one position, mainly at points subjected to protracted pressure of the body weight, i. e., in the region of the sacrum, shoulder blades, elbows and heels (in patients lying on the back), and in the region of the trochanter, crest of the ilium, elbows, thighs and ankles (in patients lying on a side). Lastly, in some cases bedsores develop in places of contact of cutaneous surfaces, for example, the inner surfaces of the thighs, at the knee joints, on the skin under the breasts, etc. The appearance of bedsores is also favoured by an insufficiently even surface on which the patient is lying, creases and crumbs on the sheet and moistening of the skin at the points of pressure with

urine, pus or other excretions. Bedsores are formed particularly frequently in thin, emaciated and weak patients, in corpulent patients, and not infrequently also during the postoperative period, when the patients lie motionlessly because of pain. Appearance of bedsores is also favoured by humidity and intertrigo of the skin mainly in patients suffering from rectal and urinary incontinence. Lastly, bedsores develop particularly rapidly and easily in a number of diseases of the peripheral and central nervous system, for example disorders of innervation and injuries and diseases of the spinal cord.

To prevent bedsores, it is necessary carefully to watch the patient's skin. Grave and postoperative patients are placed on a rubber ring, the points of pressure are examined several times a day and the skin is rubbed down with camphor or ethyl alcohol. A bedsore begins with the appearance of a dark or red spot at the point of pressure, after which the portion of the skin turns brown and grows insensitive; the superficial layer of the skin becomes desquamated and a section of necrotic tissues is formed; a purulent process may develop under the necrotic tissues. Treatment of bedsores consists in painting the necrotic portions with iodine tincture, removing the dead tissues and applying dry aseptic dressings; after removal of the dead tissues ointment dressings are applied. Strict cleanliness is required. General treatment consists in improving the patient's nutrition.

Ulcers. A granulating surface which appears after injury or a purulent process gradually tends to heal if the surface is not very large. In some cases, however, the tissues of a granulation surface decompose and the wound becomes larger and sometimes deeper, i.e., an ulcer is formed. The floor of the ulcer may be covered with granulations, but since they scarcely tend to develop and grow, the ulcer does not heal. Ulcers appear in different parts of the body, but most frequently on the shank. Cancerous, syphilitic, tuberculous, trophic and simple ulcers are distinguished, depending on their causes. Simple ulcers are a result of long-continued thermal, mechanical or chemical stimulation which, injuring the granulations, impedes healing. Ulcers may also be due to low resistance of the organism to stimuli, as a result of different diseases. Trophic ulcers are due to disorders of the regulating influence of the nervous system on tissue nutrition. They may appear as a result of affections of the central nervous system, as well as disorders of peripheral innervation, and reflexly during stimulation of other parts of the nervous system.

One of the most frequently encountered and stubbornly unhealing ulcers (varicose) develops in cases of varicose veins of the thigh and shank (see *Varicose Veins*).

VASCULAR DISEASES

Aneurysms. A dilatation of a part of an artery forming a blood-containing sac is called an aneurysm. If the walls of the artery have been preserved and they form the walls of this sac, it is a *true* aneurysm as distinguished from a *false* aneurysm which will be discussed below. Aneurysms develop in cases in which the elasticity of the arterial wall is disturbed, which causes a dilatation of the artery or a distention of its walls; the distention tends to increase under the influence of blood pressure. Aneurysms are cylindrical or spindle-shaped. The causes of aneurysms are: degeneration of the vascular walls, inflammatory phenomena, syphilis and recurrent traumas.

In wounds caused by a pointed instrument, bullet or splinter the wall of a vessel is also not infrequently injured. The blood flows out into the surrounding tissues and partly coagulates, the resulting clots and the surrounding tissue forming the wall of the sac which is connected with the vessel and contains liquid blood (Fig. 221). This disease is referred to as a *traumatic* or *false aneurysm*. This aneurysm is usually sac-shaped and is stable only in exceptional cases. Most frequently, however, under the pressure of the blood which flows out of the hole in the artery the sac becomes distended and the aneurysm rapidly enlarges. In addition to arterial aneurysms, there are also arteriovenous aneurysms in which the vein and artery communicate and arterial blood gains entrance into the vein (Fig. 222).

As the aneurysm grows, it compresses the veins, rendering blood circulation difficult; cyanosis and edema appear below the aneurysm. The capsule of the aneurysm adheres to the adjacent organs (for example, nerves), and may disturb their function. If an aneurysm compresses a nerve, pain appears; progressive enlargement of an aneurysm may result in its rupture with a fatal hemorrhage. *Signs of aneurysms*: appearance after injury, at the place conforming to the position of the artery, of a round or oval swelling which pulsates and yields murmurs on auscultation. On compression of the artery between the heart and the aneurysm the pulsation and murmurs disappear.

Treatment of traumatic aneurysms. Since an aneurysm by gradually enlarging, compressing the adjacent organs and threatening a rupture and hemorrhage is dangerous to the patient, surgery is the only correct treatment. There are several surgical methods of treating aneurysms. One of the oldest and most reliable methods consists in the following. The artery and the aneurysmic sac are laid bare. The artery is ligated as closely as possible to the point of its entrance into the sac and at the point of its exit from it. Then all the small vessels emptying into the sac are successively ligated. The sac is separated from the tissues

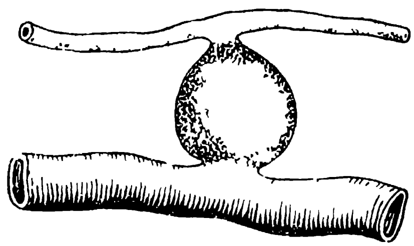


Fig. 221. Arteriovenous aneurysm

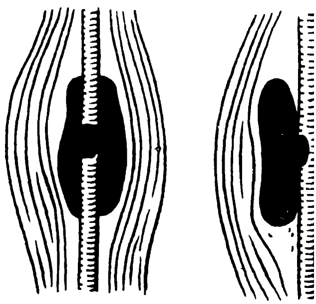


Fig. 222. Traumatic aneurysm (diagram)

that surround it and from its adhesions and is removed. The blood supply of the underlying sections of the limb is ensured through collaterals (roundabout blood circulation). For better development of collateral circulation the artery above the aneurysm is purposely compressed several times a day during the period of the patient's preparation for the operation.

This method and other analogous methods of treating aneurysms surgically are called ligature methods. The shortcoming of the ligature methods consists in the fact that they sometimes develop various circulatory disorders in the underlying parts of the extremity.

To preserve or restore the blood flow to the underlying parts of the extremity, the part of the artery at which the aneurysm is located is now very frequently excised and the ends of the artery are connected with each other by a vascular suture. In favourable cases the blood circulates in the injured extremity after such operations as it does in uninjured extremities.

A third type of operations has gained wide currency in recent years. During these operations, after excision and removal of the affected part of the artery together with the aneurysmic sac, a

portion of vessel taken from a corpse and specially treated (conserved) is sutured in the defective place. The conserved vessel is very frequently replaced by various prostheses (tubes) made of different synthetic materials.

The same aid is administered for ruptures of aneurysms as for other arterial hemorrhages: compression, application of a tourniquet and urgent surgical intervention.

Varicose Veins (varices venarum). Distention of veins in the form of separate nodes interconnected by usually distended venous trunks is called varicose veins. Varicosities are most frequently observed in the lower part of the rectum and the region of the anus (hemorrhoids), the lower extremities in the area of ramification of the subcutaneous veins (varicose veins of the shank and thigh) and in the region of the spermatic cord and the scrotum (varicocele).

The disease is caused mainly by low tone of the vascular wall resulting from disordered innervation and its weakness with subsequent trophic disturbances. The predisposing causes apparently lie in mechanical difficulties of the outflow of blood, the appearance of hemorrhoids being fostered by sedentary work and constipation or work connected with lifting weights, whereas the appearance of varicosities on the shanks is favoured by occupations which require long standing and marches and hard physical labour. All these cases involve congestion of blood in the veins, difficulties of its outflow from them and, as a result, distention of the veins, distention of and changes in their walls. In some cases the distention of veins may be a direct result of their compression in the pelvic region, for example, in tumours. The main causes of the disease are weakness of the venous wall, underdevelopment of the valves in the veins and sclerotic changes in their walls.

The patients' complaints vary and depend on the region in which the varicosities are located.

Treatment of varicose veins consists primarily in eliminating their causes (sometimes even in changing the occupation).

Various therapeutic measures may be adopted to relieve the patient's condition and improve the circulatory conditions, thereby favouring decreased tension and sometimes obliteration of the varicosities. These include tight bandaging of the shanks with elastic bandages from the foot to the upper part of the thigh; the bandages are put on in the morning before rising and are left on for the whole day. In addition to disorders of venous circulation, disturbances in lymphatic circulation are often observed at the same time. Disturbances in lymphatic circulation occurring simultaneously with a thickening of subcutaneous tissue, so-called. elephanthiasis, are particularly important. The latter usually occurs after recurrent inflammatory, for

example erysipelatous, processes. Varicose veins are treated surgically.

Under the varicosities hemorrhages are possible during ruptures of the thinned walls of the veins or their destruction by an ulcerative process.

The picture of such hemorrhages is sufficiently clear because of the signs of a venous hemorrhage. The aid administered in such cases is the same as in other venous hemorrhages, i.e., it suffices to put the patient in a recumbent position, raise his leg and slightly compress the bleeding point with a sterile dressing to arrest the hemorrhage. To prevent recurrence of the hemorrhage, the patient must be confined to bed for several days.

TUMOURS

A tumour or neoplasm is a growth consisting of cells of the organism, which differ from normal cells in their structure, processes of nutrition and metabolism. "A neoplasm in the organism is the clearest manifestation of disturbed regulation of growth and reproduction" (N. Petrov). The cells of tumours do not display any tendency to regular development, but possess a property of progressive multiplication. A tumour has but apparent independence (autonomy) because the organism influences the emergence and course of development of the tumour. The development of a tumour and the processes operating in it depend on the changes in the entire organism. The influence of endocrine glands and their hormones on the growth of the tumour is particularly noticeable.

The close dependence of the development of tumours on processes in the organism warrant the assumption that a tumour is a local manifestation of a disease of the whole organism (neoplastic disease).

Tumours consist of atypical cells differing in form and size from the original tissue. They grow by reproduction of the cells of the original embryonal rest, displacing and replacing the cells of the adjacent tissues. Some tumours have multiple embryonal rests. The rapid and irrepressible growth is a new ability acquired by the tumoral cells which do not lose this ability even after the cause of the tumour has ceased to act. For example, in cancer of the skin produced by roentgen rays the process does not cease but continues after the exposure to the rays has ended.

The overwhelming majority of tumours have a structure similar to an organ (organoid) or tissue (histioid) and consist of two tissues: parenchyma—the tissue proper of which the tumour is formed, and stroma—supporting tissue of the tumour with the vessels nourishing the tissue.

Tumours are formed of cells of the tissues of the affected organism. Each tissue gives rise to a tumour similar to itself in structure (for example, lipomas are formed from fatty tissue), but

sometimes tumours originate from other tissues (for example, cartilaginous tumours in the tissue of salivary glands). In such cases tumours arise from embryonal rests which were in these tissues during fetal life or as a result of transportation of tumour cells to new places.

Benign and Malignant Tumours. For practical purposes tumours are divided into benign and malignant, but in a number of cases this difference is obliterated.

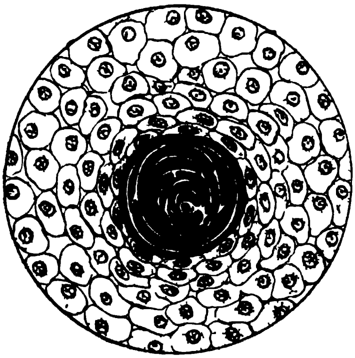


Fig. 223. Diagram of expansive growth of a tumour

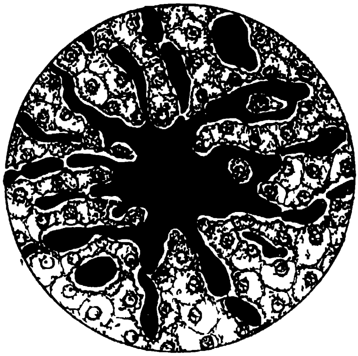


Fig. 224. Diagram of infiltrative growth

Benign tumours consist of mature tissue and grow by parting the adjacent tissues; in most cases they do not grow rapidly, do not grow through adjacent tissues, and there are no metastases or cachexia (emaciation).

After once appearing, the tumour grows ceaselessly. Periods of rapid multiplication of the tumour cells may alternate with periods of their slower development. In developing the tumour pushes aside the tissues of the organ in which it has formed, remaining demarcated from it, while a connective tissue sac (capsule) frequently develops around the tumour. Such growth is called expansive (Fig. 223).

Malignant tumours consist of immature tissue.

The main distinguishing features of malignant tumours are their penetrating growth into the adjacent tissues, tendency to be carried along the lymphatic or circulatory system to other organs (metastasis) (Table VI) and relapses after their excision. I. Pavlov thought it possible that a trophic reflex on the part of the tumour paved the way for its spread. Rapid growth of tumours and the emaciation they cause are not constant signs. Their growth into the adjacent tissues occurs by permeation of the tumour cells into interstitial spaces, destruction and replacement of the cells of the adjacent tissues. Such growth is called infiltrative (Fig. 224). By developing in a new place the tumour

cells produce a secondary tumour (metastasis) which retains the structure of the maternal tumour.

Relations Between Tumour and Organism. A tumour most frequently arises in but one place and only some benign tumours are primarily multiple. Subsequently, as the tumour grows it compresses the adjacent organ, malignant tumours usually penetrating into intestitial spaces, destroying and replacing the cells of the neighbouring tissues (Table VI), while the groups of cells disengaged from the maternal tumour are carried along lymphatic and blood vessels to a new place where they either die or produce a new filial tumour, sometimes much larger and with more pronounced symptoms than the primary tumour.

Four periods are distinguished in the development of a tumour: the first period in which the tumour is manifested by the extent to which it has spread as a local disease; the second period in which the tumour has begun to spread to the adjacent tissues and along the lymph vessels to the closest lymph nodes; the third period in which it infiltrates into the adjacent tissues and produces metastases into more distant lymph nodes, and the fourth period which is characterised by general phenomena of cachexia and distant metastases.

The processes of growth, nutrition and metabolism of a tumour are dependent on the same processes throughout the organism. The greatest influence on the development and growth of a tumour is exerted by endocrine glands and the reticuloendothelial system. Age is of some importance in the development of certain tumours. For example, sarcoma is observed for the most part in young people and cancer in more mature people.

A tumour affects the general condition of an organism by its profuse hemorrhages and secondary infection caused by its decomposition and ulceration (to which cancerous tumours are particularly inclined). But in a number of cases the patient's poor condition must be explained by the effect of the tumour on the composition of the blood and on metabolism (cachexia). Cachexia is characterised by the patient's general weakness, emaciation, earthy colour of the face, flabby and dry skin, anemia, increased protein decomposition, etc. After surgical removal of tumours the latter not infrequently recurs at the old place or near it (relapse), developing for the most part from the remains of the basic tumour.

Causes of Tumours. Although tumours may be produced experimentally their causes are not yet very well known. A considerable number of benign tumours originate from embryonal rests which are demarcated from the surrounding tissues. During the development of the fetus and formation of organs processes of tissue displacement operate. If these processes operate abnormally, tissues are included in organs which usually do not

have such tissues, for example, cartilaginous tissue may be included in the parotid gland. These are so-called dormant rests which for years and even decades do not in any way manifest themselves but retain their ability to grow and develop. Under the influence of some external factors, quite clear in some cases and impossible to explain in others, such rests begin to grow and tumours develop. Hence the attempt to explain the origin also of malignant tumours by inborn defects of tissue development (Cohnheim). This theory has not been adequately substantiated and does not solve the problem of the origin and growth of tumours, especially since experimental tumours are produced without any connection with embryonic developmental defects.

For most malignant tumours it must be assumed that cells with reduced specificity (anaplasia) are more capable of living independently. This state is a result of the changes in the physicochemical properties of the cells or changes in their proteins which are followed by changes in their biological properties. Such changes in the properties of the cells may be caused by many factors and, in the first place, various irritations, sometimes imperceptible and in other cases, for example in experimental tumours, well known. The theory of irritation which is based on these facts is the most widespread theory of the origin of malignant tumours, but it also explains too primitively and incorrectly the development of tumours as a result of local changes in the tissues.

Both theories connect the development of cancer only with local factors without taking into account the general changes in the organism and the role of the central nervous system. Local changes in the tissues are of some importance as precancerous states, whereas irritation is an additional and not the basic etiological factor.

The third of the best known theories is that of the infectious origin of tumours. Animals are known to have tumours caused by filtrable viruses. A great deal of attention is devoted to them in the study of tumours in man (L. Zilber), but their role in human tumours has not yet been demonstrated.

The regeneration theory is a further development of the theory of irritation; this theory is based on a pathological regeneration of tissues subjected to protracted traumatisation According to the regeneration theory, a tumour arises in cases in which it is fostered by the general condition of the organism. This point of view makes intelligible the significance of age and premature wear and tear of the patient's organism, disorders of metabolism and hormonal regulation. But this theory does not give adequate consideration to the importance of the state of the nervous system for the malignant growth.

So prominent a clinician as G. Zakharyin held that development of cancer was favoured by age and grief. The experiments

TABLE VI

Sarcoma of the jaw with metastases to the mamma and the inguinal region

TABLE VII

Cancer of the skin

of I. Pavlov's pupils—M. Petrova and A. Speransky—indicate that the central nervous system, i.e., its grave psychic traumas, plays a very important role in the development of tumours.

Lastly, it is also believed that different tumours may be caused by different factors.

Of enormous importance for the problem of cancer is the fact that the appearance of tumours, especially cancerous tumours, is not infrequently preceded by a number of changes in the tissues designated by the term—precancerous states (diseases). These diseases differ for different forms of cancer, but chronic inflammatory or ulcerative processes. certain benign tumours and changes in the epithelium in the region of fissures and cicatrices are most frequently observed.

Public Control of Malignant Neoplasms. The large number of patients with neoplasms, mainly cancerous, the gravity of the course of these diseases, and the large percentage of lethal outcomes, especially in neglected cases, have brought to the fore the question of public measures of controlling these tumours.

The measures of preventing cancerous diseases must be aimed mainly at personal prophylaxis. Particular attention must be devoted to treating precancerous diseases as the most effective prophylaxis of cancer. Work with irritating substances at certain enterprises requires measures of protecting those who work with these substances. In roentgen offices the personnel must be protected from the action of roentgen rays.

Public control of cancerous diseases is aimed mainly at early identification, since treatment of cancer is successful only at early stages. This control presupposes primarily extensive popularisation among the medical personnel of information concerning early diagnosis of cancer and creation of a network of institutions where such diagnosis may be made. Furthermore, it requires extensive health education among the working people, popularising the information that cancer in the incipient stage is curable, and that early application for aid in any suspicious disease is necessary.

Particular attention is now being devoted to questions of controlling cancerous diseases.

Extensive explanatory work among the population is being carried on with the aid of leaflets and placards aimed at persuading everybody that cancer is incurable only when neglected and when no attention is paid to the initial symptoms of the disease.

Such a system of public health services facilitates systematic control of cancerous diseases, enhances the effectiveness of this control and makes it possible to reduce the number of hopeless inoperable cases and to increase the chances for identifying early forms of cancer.

Classification of Tumours. Tumours are divided into groups, according to the tissues of which they consist:

1) epithelial: benign—papillomas (nipple-like), adenomas (glandular) and cysts (bladderlike); malignant—cancers (carcinomas);

2) connective tissue: benign—fibromas (consisting of connective tissue), lipomas (consisting of fatty tissue); malignant—sarcomas;

3) vascular: benign—angiomas;

4) muscular: benign—myomas;

5) neural: benign—neurinomas (nerve tumours) and gliomas (brain tumours);

6) mixed: benign and malignant;

7) complex tumours consisting of many tissues (teratomas).

Benign Epithelial Tumours. 1. *Papillomas* or pediculate tumours are benign tumours of the skin and mucous membranes. Papillomas consist of a connective tissue base (pedicle) covered by multi-layered epithelium; on the skin they have a warty and petaloid appearance, and on the mucosa of the urinary bladder a villous appearance. Papillomas grow only in the direction of the free surface of the skin and mucosa. They produce a severe disease only when occurring in the urinary bladder where they cause hemorrhages. They grow slowly, but may degenerate malignantly. Skin papillomas can be treated surgically, whereas papillomas of the bladder are treated by electrocoagulation (through a cystoscope) owing to their tendency to relapse.

2. *Adenomas*, *cystomas* and *cysts* are glandular tumours whose epithelium lines lobate, tubular or bladderlike cavities (cysts). Many of these tumours are likely to develop into glandular cancer. Adenomas are found in all parts of the body where there are glands, but particularly frequently in glandular organs (mammae, ovaries, uterus) and on the mucous membranes of the nose and intestines. Glandular tumours usually grow slowly, but rapidly growing forms producing metastases (malignant adenomas) and developing into cancer are also observed.

Adenomas of the nasal and intestinal mucosa are pediculate tumours and are called polyps. In the nasal cavity they obstruct the nassal passages, which renders respiration difficult, and support inflammatory processes in the nose. In the rectum polyps not infrequently ulcerate and produce hemorrhages.

Treatment—removal with a loop (in the nose) or excision together with the pedicle (in the rectum).

Of the cystous forms we shall consider only dermoid cysts—saccate formations which develop because of immersion of small particles during fetal development. They are found on the head, neck and other parts of the body, and consists of a dense membrane enclosing a gruellike mass consisting of a mixture of skin fat and desquamated epithelial scales. These tumours grow slow-

ly. Suppuration may be mentioned as one of the possible complications.

Treatment—excision together with the capsule.

Traumatic epithelial cysts and cysts of the sebaceous glands (atheromas) externally resemble the preceding tumours. Atheromas often appear as a result of obstruction of the ducts of sebaceous glands (retention cysts), which leads to accumulation of the content, i.e., the same mass as in dermoids. The sac of an atheroma is the distended capsule of the sebaceous gland. Atheromas form in the thickness of the skin. A white or black point—obstructed duct of the sebaceous gland—is not infrequently found on the top. Suppuration of the atheroma is a rather frequent complication.

Treatment—incision with curettage of the cavity in cases of suppuration and complete excision together with the capsule in noncomplicated cases.

Cystous glandular tumours are not infrequently found in the jaws (so-called dentigerous cysts), ovaries (ovarian cysts, sometimes of enormous sizes) and in a number of other glandular organs.

Malignant Epithelial Tumours—Cancers or Carcinomas. Cancerous tumours are of extraordinarily great importance. All that has been said about tumours, the peculiarities and malignancy of their growth pertains, in the first place, to cancerous tumours.

Primary cancer is found in all the organs of the human body where there is epithelium; it is capable of spreading by metastases to all organs without exception. The organs predominantly affected by cancerous diseases are the stomach, uterus, mammae, intestines, esophagus, skin and lungs. Histologically planocellular and cylindrocellular cancers are distinguished. Changes in the epithelium, consisting in its acquisition of an atypical structure and its penetration into the underlying connective tissue, are considered signs of a cancerous tumour.

The rapid growth of a cancerous tumour and its inadequate blood supply not infrequently condition degeneration of the tissue, in some places to the point of complete mortification and decomposition, which produces an ulceration of the tumour.

A primary cancerous tumour develops mainly by multiplication of the original cancerous cells (Table VII). The development of a cancerous tumour depends upon the general state of the organism and the state of its nervous system. Subsequently the tumour spreads to surrounding tissues, affects the adjacent lymphatic vessels and produces metastases in the organs through the blood stream. This causes emaciation of the patients (cachexia), etc. Outwardly cancer looks like a cicatrising tumour which shrinks and contracts the organ, for example the gland,

or like a tumour with excessive tissue growth (Table VII), or, lastly, like an ulcer. The external appearance of cancer varies with the place and character of its development. Cancer of glands, for example, of the mammae, looks like a dense node which quickly adheres to the surrounding tissues and not infrequently shrinks the affected organ with cicatrices (Fig. 225).

Fig. 225. Cicatrising cancer

Cancer connected with the skin and cancer of the mucous membranes very rapidly ulcerate. These forms of cancer have a typical appearance of ulcers with dense, frequently undermined edges and a fatty, dirty floor covered with decomposed tissue (Fig. 226).

During its growth a cancerous tumour destroys all the adjacent tissues, sometimes extending from one organ to another (for example, from the esophagus to the bronchi), destroys bones and leads to pathological fractures.

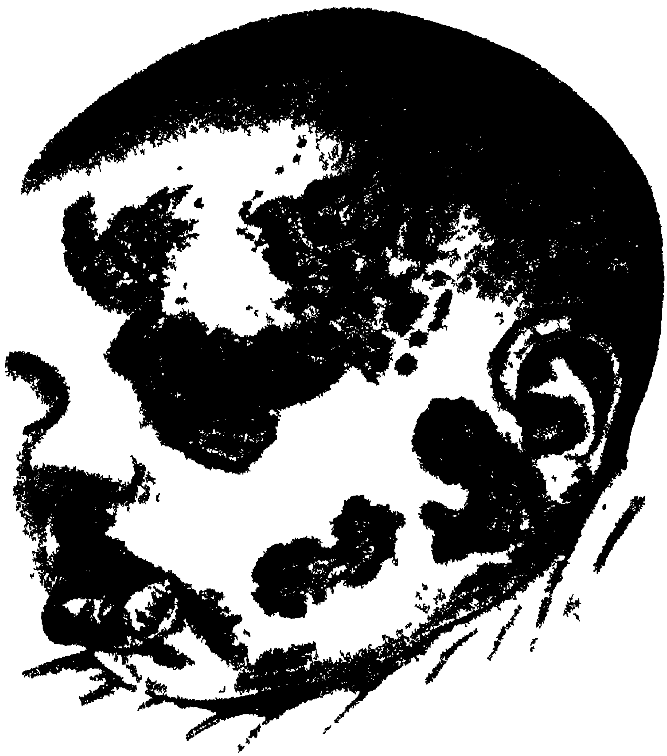
Fig. 226. Cancerous ulcer

A cancerous tumour at first spreads along the lymphatic vessels to the closest lymph nodes, but also penetrates into the blood vessels, producing distant metastases in different organs or general cancerous insemination (miliary carcinomatosis). In cancer cachexia is usually very strongly pronounced; it appears sooner, for example, in cancer of the stomach and much more slowly in cancer of the mammae, uterus, and skin.

The course and duration of cancer vary with the place it affects—from several months to several years, a longer course taken only by some cancerous diseases of the skin and the mammae.

The first signs of the appearance of a cancerous tumour vary with the organ in which cancer develops. It should be noted that in the beginning the disease is painless and that is why patients often pay no attention to it for a long time.

Benign Connective-Tisue Tumours. 1. *Fibromas* are tumours



Cavernous angioma

resembling in structure dense connective tissue; they are found in almost all the organs of the body, but most frequently on the skin, in subcutaneous tissue, nerve trunks and in the uterus. In most cases they grow slowly and may grow to tremendous size (for example, fibromas of the uterus).

2. *Lipomas* are fatty-tissue tumours, usually lobate, sharply demarcated, with a dense capsule growing slowly, but sometimes to considerable size. They appear in any place and not infrequently are multiple. They are almost always benign and are easily removed surgically; no relapses are observed.

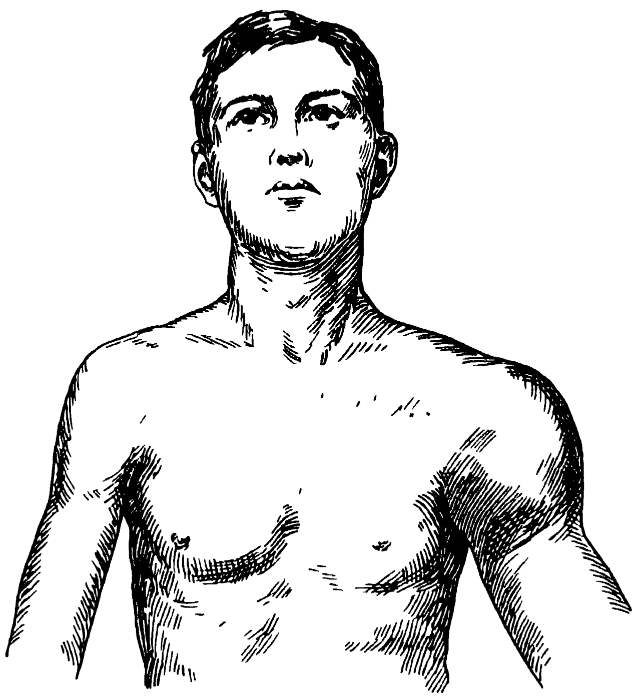


Fig 227. Sarcoma of the shoulder

3. *Chondromas*—tumours made up of cartilaginous tissue and *ossteomas*—tumours formed of bony tissue usually originate from the cartilages and bones of the skeleton. They develop slowly and may take a malignant course (chondrosarcomas and osteosarcomas). Sometimes these tumours are multiple. They produce considerable deformities, especially of the small bones. Their excision not infrequently disturbs the functions of the affected part.

Malignant Connective-Tissue Tumours—Sarcomas. The structure of sarcomas varies rather widely and depends on the type

of cells of which the tumour consists (round, spindleshaped and giant cells) and on the presence in the tumour of cells of the tissue from which the tumour has appeared (chondro-, fibro- and osteosarcomas). Sarcomas most frequently develop in young people, grow quickly, not infrequently attain large sizes (Fig. 227), distend the cutaneous vessels, grow through and destroy all surrounding tissues, including bones, and produce metastases through the lymphatic and, rather early, through the circulatory system.


Fig. 228. Lymphangioma of the cheek

A permanent cure is possible only by removal of the tumour within the limits of healthy tissues, and on the limbs—not infrequently by amputation of the limb.

Angiomas are vascular tumours. They are very widespread and are of an inborn character. Sometimes they persist without enlarging all through life, for example, so-called birthmarks. In other cases they begin to grow, compress adjacent organs, thin out the skin or mucous membrane and not infrequently cause extensive hemorrhages.

Arterial angiomas, venous angiomas (cavernous) (Table VIII) and angiomas consisting of lymphatic vessels (lymphangiomas) (Fig. 228) are distinguished.

Myomas—tumours composed of muscular tissue, most frequently of the smooth muscle fibres of the internal organs; they are usually benign and grow slowly; sometimes their growth is arrested and they even diminish in size. Only myomas of the uterus grow to a large size. These tumours are easily cured surgically and roentgenologically.

Neurinomas—tumours composed of nervous tissue, run a benign course, but may cause very intense pains. After their removal the sensitivity and mobility in the region innervated by the affected nerve are frequently disturbed.

Gliomas are tumours composed of cerebral tissue most frequently found in the cranial cavity. They are very dangerous because of their pressure on the brain; they grow rapidly, are removed with great difficulty and not infrequently produce relapses.

Complex Tumours. Complex tumours consist of many different tissues and are formed as a result of embryonic misplacement of tissue. Sometimes these tumours have, as inclusions, particles which resemble various organs (for example, extremities, the head, different glands, teeth). Such tumours are called teratomas.

They appear most frequently in the sacral region and in ovaries, usually run a benign course and are permanently cured by surgical treatment.

TREATMENT OF TUMOURS

The most reliable method of treating tumours is their surgical removal, benign tumours being excised on the borders with the surrounding tissues and malignant tumours with considerable sections of the adjacent healthy tissues so as not to leave any parts of the tumour which have grown into the adjacent tissues. Such removal within the limits of healthy tissues does not completely guarantee that all the remnants of the tumour have been removed; the entire subcutaneous tissue with the lymphatic vessels and adjacent lymph nodes is usually removed together with the tumour. If a tumour or lymph node have been incised accidentally, the instruments are immediately sterilised and, if the parts being removed have contacted the adjacent tissues, the latter are cauterised.

Such an operation must prevent the tumour cells from gaining entrance into the wound and from developing (relapsing).

In addition to operations of completely removing tumours (radical operations), a number of other operations are performed for cancer; these somewhat restore the functions disordered by the tumours (palliative operations), for example, making a fistula in the stomach to nourish patients whose esophagus is obstructed by a cancerous tumour. Another method of treating tumours is that of using roentgen rays and radium. Treatment with roentgen rays is effective only in some cancers of the skin, fibromas and cancers of the uterus and cancers of the mammae, while treatment with radium is effective in the same cancers and in some cancers of the mucous membranes, for example, of the mouth and tongue.

Treatment with roentgen rays and radium fails to produce any favourable results in cancers of the stomach and intestines.

Lastly, to improve the general condition of the patient, the latter is given medicinal treatment aimed at controlling hemorrhage from the tumour, cachexia, etc. Patients with malignant tumours are particularly disposed to all sorts of complications and diseases. With slight neglect in their care they develop grave complications and secondary disease which may prove fatal. Pneumonia and thrombophlebitis are the most frequent complications.

Postoperative wounds sometimes heal poorly and slowly and not infrequently suppurate.

PART TWO

CLINICAL SURGERY

INJURIES AND DISEASES OF THE FACE AND HEAD

Wounds. Wounds in the soft parts of the head and face are frequently accompanied by considerable hemorrhages because of the rich blood supply to the face and integuments of the skull. First aid during such hemorrhages consists in application of a pressure bandage, and during profuse arterial hemorrhages from the branches of the external temporal and external maxillary arteries—compression of the vessels. The external temporal artery is compressed in front of the helix, and the external maxillary artery—at the edge of the lower jaw in front of the masticatory muscle. The hemorrhage may be completely arrested only by ligation of the bleeding vessel.

Like all wounds, those of the face and head must also be subjected to primary treatment. Owing to the well-developed network of blood vessels the wounds in soft tissues heal very well and almost always by first intention.

The basic method of treating such wounds consists in an operation and suturing as soon after the injury as possible.

Injuries to the Nose. The most frequent injuries to the nose are fractures of the nasal bones. They are often accompanied by ruptures of the mucosa of the nasal cavity and may therefore be regarded as open fractures. Signs of fracture of the nasal bones: pain in the region of the bridge of the nose, hemorrhage from the nose and its deformation.

First aid consists in rest and external application of ice. To set the bones in their proper position, the physician packs the nasal cavity with vaseline-oil tampons which must be changed daily.

Hemorrhage from the Nose (epistaxis). Bleeding from the nose may be caused by various factors. It may be the result of local causes, for example, injuries to the nose, ulcers in the septum after operations in the nose, etc.; not infrequently it is a result of an abnormal general condition of the organism, for example, changes in the vascular wall in cases of anemia, chlorosis, cardiac failure, etc. Bleeding from the nose is observed still more

frequently in general infectious diseases: measles, scarlet fever, influenza, typhus, sepsis. Menstrual bleeding may also be replaced with bleeding from the nose. The vessels of the nasal septum and of the anterior ends of the conchae bleed most frequently. Blood flows not only to the exterior through the nares, but quite often also into the pharynx and stomach, causing the patient to cough

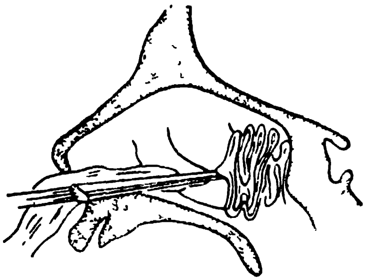


Fig. 229. Anterior nasal tamponade

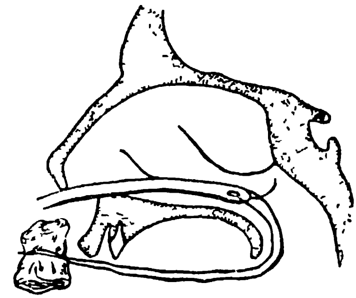


Fig. 230. Posterior nasal tamponade: introduction of the tampon

up and even vomit blood. The hemorrhages, especially if they recur, may be so profuse as to endanger life.

During administration of first aid in cases of epistaxis everything that may contribute to its intensification must be eliminated.

The patient is often greatly excited: he moves, sits bending over a basin, blows his nose and tries to expectorate blood, washes his nose with cold water or vinegar. The patient must be tranquilised, forced to lie down or sit down, asked not to speak or blow his nose, to try not to cough and generally not to strain. The patient's collar must be unbuttoned and a bag with ice or snow or a cold compress applied to the region of the nose and bridge of the nose.

The simplest method of arresting a nasal hemorrhage is a tamponade with a cotton ball and lowering the head rather than throwing it back, as is usually done, because only in this case does the blood accumulate on the cotton tampon, coagulate and cover up the bleeding place, whereas throwing the head back makes the blood run into the nasopharynx instead of running to the exterior. The nostrils may also be simply clamped with two fingers, or a cotton ball may first be introduced into the bleeding nostril. The nostrils must be compressed rather strongly and as high as possible for a period of 3-5 minutes, during which time the patient breathes through the mouth. In most cases these measures suffice, otherwise an anterior or posterior *tamponade of the nose*, which is the most effective measure, is made.

To introduce a tampon into the nose (anterior tamponade), a long narrow tampon of sterile gauze is used. The bleeding nostril is dilated by a nasal speculum and the tampon is introduced by a nasal forceps deep into the nose along the lower wall of the nasal cavity (Fig. 229), following which the nasal cavity is filled with gauze from the inside towards the exterior. To avoid complications (inflammatory process of the mucosa, ulceration), the tampon must not be kept in the nasal cavity for more than 12-24 hours.

In cases of severe hemorrhage in the posterior parts of the nasal cavity a posterior tamponade of the nose is resorted to. A round tampon is prepared from sterile gauze and is firmly tied with a sufficiently heavy, sterile thread with three ends. A rubber catheter is introduced through the lower nasal passage in the direction of the nasopharynx until its end reaches the nasopharynx and can be seen through the mouth; then the catheter is withdrawn through the mouth with forceps. Two threads from the tampon are fastened to the withdrawn catheter (Fig. 230) and the latter is pulled back by the end which protrudes from the nostril so that the tampon tied to the catheter by a silk thread comes into the nasopharyngeal cavity where it tightly plugs the nasal passages. The two threads introduced with the catheter are tied over the tampon inserted in the nostril (Fig. 231). The third thread protrudes from the oral cavity. The tampon is withdrawn with the aid of this thread. It is not advisable to keep the tampon in the cavity more than 12-14 hours.

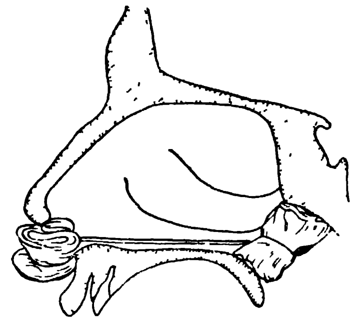


Fig. 231. Posterior nasal tamponade: fastening the tampon

Sometimes general measures aimed at enhancing blood coagulation are necessary (see above).

Foreign Bodies in the Nose. Foreign bodies in the nose are found almost exclusively in children who, while playing, put various things—sunflower seeds, beans, cherry pits, beads, buttons, etc.—into the nose. In adults mostly cotton tampons are found; these are usually inserted in the nose in attempts to paint the nasal passage. The foreign bodies gaining entrance into the nasal cavity plug up the nasal orifices and, if they stay there long enough, cause inflammation, ulceration of the mucosa with a fetid discharge and sometimes hemorrhages. Foreign bodies are removed from the nasal cavity almost exclusively with the aid of an instrument—a special hook. The intermediate medical personnel must immediately send such patients to a physician. Adminis-

tration of aid must not be delayed because there is very little hope that the foreign body will come out spontaneously; moreover, its removal is rendered difficult if inflammatory phenomena develop. Attempts to remove foreign bodies by irrigation are not recommended. The only thing that may be allowed is to ask the patient strongly to blow his nose by closing one of the nostrils or to make him sneeze by irritating the mucosa with a feather. In such cases the foreign body comes out by itself.

Inflammatory Diseases. Of the inflammatory diseases affecting the skin of the face and skull mention must be made of the erysipelatous process. This process usually runs a very stormy course and possesses quite characteristic symptoms. The erysipelatous process on the skin of the face and the skull is dangerous because the infection may be transmitted along the blood vessels (veins) to the intracranial veins; this leads to obstruction of the venous sinuses of the brain (thrombosis of the sinuses) and fatal inflammation of the meninges and the brain.

This danger exists in any purulent process on the skin of the face and the skull, and constitutes the peculiarity of the course of these processes.

Even a furuncle, which usually easily passes when located elsewhere, may run a much graver course on the face and be accompanied by high fever and severe general phenomena. Locally it may produce considerable edema of the tissues and usually an insignificant purulent discharge. The disease must be considered serious and the patient must be confined to bed. The treatment is general—antibiotics, sulfa drugs, and local—mainly heat (hot compress, fomentations, phototherapy); no surgical treatment is usually administered because it may serve to spread the infection. The patient is given rest, is prohibited to talk and is allowed only liquid food (milk, broths and jellies). Carbuncles run a still graver course and are even more dangerous on the face, especially on the upper lip.

Water Cancer (noma). Debilitated patients who have survived severe infectious diseases, for example measles, scarlet fever, typhus and dysentery (mainly children) may develop a severe inflammatory process in the region of the cheeks and lips. The disease begins with an infiltration on the mucosa of the cheek, then the infiltrate decomposes producing a putrefactive process with considerable mortification of tissues. The temperature rises, the lymph nodes swell up, and the patient may very soon die. If the patient survives, the tissues retain a defect. The treatment consists in frequent irrigation of the necrotic region with disinfectants and a diet consisting only of liquid foods. Measures favouring general strengthening of the patient must be taken and the patient must be given penicillin and sulfonamide preparations.

Inflammation of the Parotid Gland (parotitis). Parotitis—inflammation of the parotid salivary glands—is a frequent disease. There are two forms of parotitis: 1) epidemic, usually bilateral (dealt with in courses of infectious diseases) and 2) a purulent process in grave patients, for example, typhus patients and, after serious surgical intervention, as a complication in weak patients. For such patients inflammation of the parotid gland is a serious complication which may lead to death. The infection sometimes gains entrance into the parotid glands with the blood stream, but, apparently, most frequently from the oral cavity through the excretory ducts of the glands.

Fig. 232. Parotitis

Conducive to the disease are general emaciation and debility of the patient, absence of normal salivation during mastication and poor oral hygiene.

The disease begins with a swelling in the region of the parotid gland (Fig. 232), difficulty and pain in opening the mouth, and edema of the eyelids. In some cases the disease ends with that and the swelling gradually disappears. In other cases the disease progresses and produces a local purulent process which runs the course of a typical abscess or phlegmon, sometimes with necrosis of a considerable portion of the gland and with general septic phenomena. Finally, if an abscess forms, it opens spontaneously. Preventive measures for weak, emaciated patients consist in good oral hygiene. It is very important to moisten the mucosa of the oral cavity with saliva. which is best attained by normal mastication of food. If the patient cannot be given solid food, for example, after a gastric operation, it is still desirable to let the patient chew on dry bread which the patient spits out and then rinses his mouth.

Oral hygiene consists in rinsing the mouth after each meal and for very weak or comatose patients—in coating the oral mucosa with vaseline oil. Moreover, the patients must brush their teeth every day. In addition to the general treatment of the basic disease and administration of antibiotics, the patients are at first given heat treatment (hot compresses, phototherapy, fomentations); if the process progresses, surgical intervention—incision of the inflammatory focus—is resorted to.

Inflammation of the Secondary Nasal Cavities. Inflammation of the maxillary and frontal sinuses and of the ethmoid bone (ethmoiditis) are most frequently observed.

Inflammations of the sinuses may be acute, i.e., lasting from three to five weeks, and chronic, i.e., lasting several months and even years. Acute inflammation is a result of infection, mainly viral, the process most often affecting the sinuses, the virus invading them from the mucosa of the nasal cavity during acute inflammation of the latter (rhinitis).

The sinuses may become diseased by the spread of infection from the adjacent organs and from the blood.

The inflammatory process begins with unpleasant sensations in the nose, and general indisposition. Subsequently nasal breathing is rendered difficult, olfaction weakens and a profuse discharge from the nose, at first serous and then mucopurulent, appears.

The patient runs up a fever and complains of heaviness in the head, headaches and neuralgic pains which are referred to the teeth. A swelling of the nasal mucosa with a profuse discharge, most frequently from one side, is also observed.

More accurate diagnostic data are obtained by internal examination of the nasal cavity, transillumination of the sinuses (diaphanoscopy) and by a roentgen picture. A puncture of the maxillary sinus is also made for diagnostic and therapeutic purposes.

In acute cases a penicillin irrigation and physiotherapy are administered first.

An acute inflammatory process in the sinuses may develop into a chronic process and become the source of general infection and intoxication. The most frequent symptoms are a stopped-up nose and unilateral discharge of a seromucous fluid, headaches and signs of general intoxication. The diagnosis can be made by a special examination. If therapeutic treatment of chronic inflammation of the maxillary and frontal sinuses proves ineffective, surgical treatment is resorted to. The operation consists in a curettage of the cavity with a bone scraper and of draining the cavity. In addition to the instruments used in operation on soft tissues, a mallet, narrow gouges, raspatories and elevators, bone scrapers and special bone-cutting forceps are prepared for this operation. The inflammatory process of the secondary nasal cavities is dangerous in that from the sinuses it may spread to the meninges and the brain.

Foreign Bodies in the Ear. Foreign bodies in the external auditory meatus are most frequently found in children when, out of mischief, they insert in their own or in each other's ears various objects—sunflower seeds, cherry pits, beads, buttons, peas, etc. Foreign bodies are sometimes found in adults as a result of such uncivilised practices as putting garlic, onions, marine rope, etc., in the ear for therapeutic purposes. In some cases pieces of objects with which the ears were picked remain in the ears; sometimes cotton balls are left in the ears, and now and

then insects (roaches, bedbugs, fleas, moths, etc.) crawl into the ears. Lastly, intense secretion by the sweat and sebaceous glands most frequently produces ceruminal plugs in the ears, resulting in symptoms resembling those produced by foreign bodies.

The symptoms which make it possible to judge of the presence of a foreign body in the ear, and the character of the aid administered vary with the foreign body—insect or object. The latter may not produce any morbid symptoms in the external auditory meatus if it does not plug it up completely. Only if the auditory meatus is completely obstructed does the patient feel something extraneous in the ear and develop deafness or a buzzing in that ear. These cases do not particularly require urgent aid, and the intermediate medical personnel are not allowed to remove foreign bodies; the patient must be sent to an aurist (physician specialising in ear diseases). Attempts to remove the foreign body by the patient himself or those in his immediate surroundings should be absolutely prohibited because they may push in the foreign body deeper, may break the tympanic membrane and introduce infection; as a result, inflammation of the middle ear may occur, may spread to the meninges and even cause death.

A graver picture of the disease is produced by foreign bodies lodged deep in the ear and pressing on the tympanic membrane, causing attacks of vertigo, pains in half of the head, buzzing in the ears and sometimes nausea and vomiting owing to the irritation of the organs of hearing through the tympanic membrane. In such cases it is necessary to administer aid sooner, but under no circumstances by trying to remove the foreign body with instruments—forceps, probes, etc. The aid may vary with the character of the foreign body. If the foreign bodies are small and light, for example, seeds of different plants, an attempt is made to make them smaller and force them to come closer to the exterior, for which purpose half a teaspoonful of glycerin (warm) is poured into the ear. For some time the patient lies on his unaffected side and then turns to the affected side. In such cases the foreign body sometimes emerges together with the outflowing glycerin.

The basic method of removing foreign bodies from the external auditory meatus consists in repeated irrigations with water, soda solution, etc. This method may be used by the nurse if she has fully mastered this technique. When irrigating the ear, the helix is drawn upward and rearward by the left hand to straighten out the auditory meatus. An ear syringe filled with a warm soda or boric acid solution is taken in the right hand. The assistant holds a kidney-shaped basin under the patient's ear. The tip of the syringe (it is best if it has a rubber nozzle on it) is carefully inserted in the auditory meatus, but so that it does not obstruct the lumen.

The stream of water is not injected directly but against the upper wall (Fig. 233) and in spurts to produce a more intensive circulation of the liquid. In such cases the foreign body is washed out into the basin held under the ear.

The ear must be washed so that the patient may feel no pain; in some cases, however, the possibility of vertigo is not excluded. It is particularly difficult to irrigate the ears of small chil-

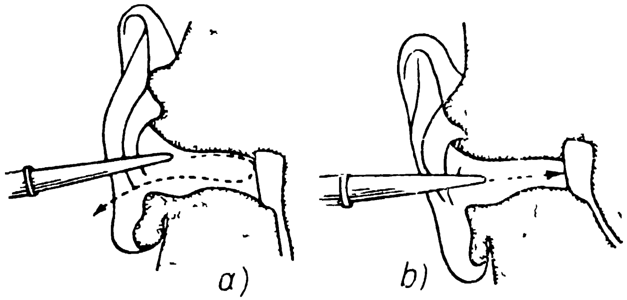


Fig. 233. Irrigating the ear: *a*—right way and *b*—wrong way

dren, since, in order to avoid injury, the syringe must be quickly removed from the auditory meatus with each movement of the child. During irrigation of the ear the assistant holds the child in his arms, gripping the child's legs with his knees, holding the child's arms with one hand and firmly pressing the child's head to his chest (Fig. 234).

The gravest symptoms are produced by insects gaining entrance into the external auditory meatus. By their movements the insects irritate the tympanic membrane and through it the organs of hearing. The patient develops intense pains and unbearable buzzing in the ear and nausea; he vomits, becomes excited and may even faint. In these cases aid must be administered at once. It consists of killing the insect by pouring warm oil, glycerin, alcohol or water into the ear. The liquid is first heated (the bottle is placed for several minutes in hot water), then the helix is drawn rearward and upward and the liquid is introduced into the ear from a pipet or in drops from a spoon.

The patient lies down for several minutes on his unaffected ear and then turns over to the affected ear, the liquid sometimes flowing out together with the foreign body.

The nurse must not use any other methods of removing foreign bodies from the external auditory meatus, but must immediately send the patient to an aurist.

Inflammation of the Middle Ear and of the Mastoid Process. Inflammation of the middle ear (otitis media) is a complication

of influenza and scarlet fever caused by the penetration of the infection from the nasopharynx through the eustachian tube into the tympanic cavity.

In small children the disease infrequently runs a symptomless course. Most often, however, inflammation of the middle ear is accompanied by fever, a rapid pulse and pains in the region of the ear, which are indicated by the child's crying. One of the true diagnostic signs is pain upon pressure on the tragus. More precise data are revealed by examination with an aural speculum. If disease of the middle ear is suspected, the patient must be examined by a physician.

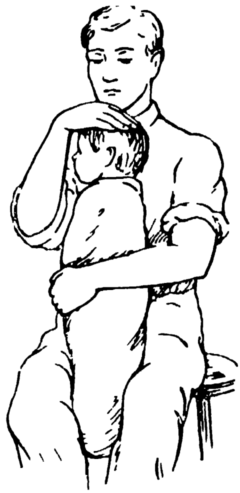


Fig. 234. How to hold a child during examination of the ear

In mild cases the process quickly ends in recovery. In serious cases it develops into a purulent inflammation involving the adjacent cavities of the mastoid process (cells). Penetration of the infection into the cranial cavity with formation of an abscess and sepsis is also possible.

Perforation of the tympanic membrane and discharge of pus from the external auditory meatus is often observed. Purulent inflammation of the middle ear tends to become chronic.

In treating acute inflammation of the middle ear it is necessary to alleviate the pain, foster resorption of the inflammatory exudate and treat the inflammatory process of the nasal mucosa. The patient is confined to bed and is administered penicillin intramuscularly and warm drops of 0.5 of phenol solution and 10.0 of glycerin in a dose of 5-10 drops two times a day into the ear. Heat is applied locally in the form of hot compresses only in the region of the mastoid process and around the helix without closing up the helix and the external orifice of the auditory meatus. To avoid irritation of the skin in children, the compress is usually applied only for the night and is replaced with a warm cotton dressing for the day. In some cases (by prescription of the physician) ice is applied in special rubber bags.

It is not advisable to wait until the content of the middle ear spontaneously breaks through the tympanic membrane because the pus that has no exit from the tympanic cavity may gain entrance into the cells of the mastoid process, which will considerably aggravate the disease and will require a serious operation.

Opening of the tympanic membrane (paracentesis) is therefore recommended (Fig. 235).

A paracentesis is performed by a specialist. For this operation a lancetlike double-edged needle and ear funnels are boiled and sterile material (cotton and tampons), ear probes and forceps are prepared for cleansing the auditory meatus from the ear wax and swabbing it with alcohol.

During paracentesis children are held fast, anesthesia being administered by instillation of drops of a 2 per cent dicaine (tetracaine) solution. Paracentesis usually quickly brings relief: the fever drops, pain subsides, and the discharge, at first profuse, gradually diminishes.

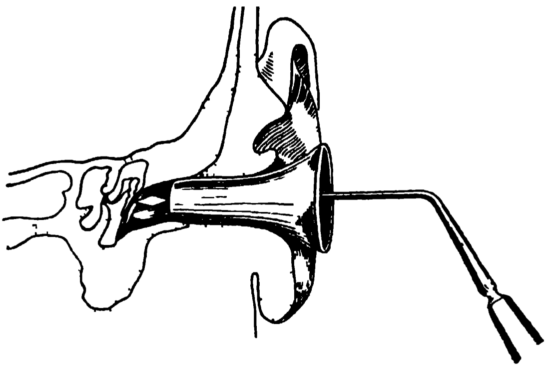


Fig. 235. Paracentesis

After paracentesis or spontaneous rupture of the tympanic membrane the external auditory meatus is loosely packed with ribbons of sterile gauze (wicks). The latter must be changed as soon as they are saturated with pus.

In some cases, especially if the patient was not treated or was treated improperly, the process may develop into a chronic inflammation of the middle ear. Cases in which the purulent inflammation lasts more than six weeks are considered chronic. The main symptoms of chronic inflammation are a discharge of pus and impairment of hearing. In these cases conservative treatment consists in instillation of drops—Hydrogenii hyperoxidati 3.0; Spiritus vini 30 per cent—30.0; Acidi borici 0.3. Dose—ten drops two times a day. Chronic inflammation additionally requires treatment of diseases of the nose and nasopharynx and general strengthening therapy. Complications and protracted purulent discharge which are not amenable to any treatment call for a radical operation.

As has already been mentioned, one of the most frequent and serious complications of purulent inflammation of the middle ear is acute mastoiditis, i.e., inflammation of the cells of the mastoid process. The following are symptoms of this disease:

pyrexia, sometimes up to 39-40°C, general feverish phenomena, pain in the region of the mastoid process upon pressure and spontaneous pains, sometimes of a pulsating character, swelling of the soft integuments in the region of the mastoid process, redness of the skin and bulging of the helix.

The essence of the process consists in penetration of the infection from the tympanic cavity into the air cells of the mastoid process and in their purulent inflammation.

Conservative treatment of mastoiditis consists in application of heat or cold. With timely surgical treatment the prognosis is generally favourable. However, if the operation is not performed in due time, the process may spread to the interior of the skull and produce pyogenic meningitis, cerebral abscess, thrombosis of venous sinuses and sepsis (otogenous sepsis).

Fig. 236. Harelip

Trephining of the mastoid process consists in an incision of the soft integuments and opening of all the cells of the mastoid process affected by the inflammation.

After the operation the patient is put to bed, his head resting on the normal side. If the dressing becomes wet, additional dressing material is added to it. It is necessary to watch the pulse, the patient's consciousness and the expression of his face which may become distorted, the distortion being a sign of injury to the facial nerve by the disease or the operation. The dressing is changed for the first time within 4-5 days, and then every other day.

Salivary Fistula. A salivary fistula usually develops as a result of injury or operation in the parotid region. The saliva, sometimes secreted in large amounts, especially during eating, may irritate the skin. To reduce salivation the patient is given liquid food and nonsour drink and is administered atropin per os or subcutaneously. The fistula is treated surgically.

Harelip (labium leporinum). Faulty development of the face manifested in a lateral cleft in the upper lip (harelip) (Fig. 236) does not require urgent intervention because infants born with this deformity usually very well adapt themselves to sucking. With a simultaneous fissure in the hard and soft palate (cleft palate) when, owing to failure of the internal edges of both palatine processes of the upper jaw to consolidate, a wide fissure exists between the nasal and oral cavities, and cold air may

enter the infant's respiratory tract, the infant easily develops catarrhal pneumonia and soon dies. The most essential factor, however, is that such infants can barely suck the breast and swallow. Milk given through a nipple remains in the fissures and decomposes. Owing to this a harelip complicated by a cleft palate is urgently operated on, i.e., sutured. In other cases the harelip is corrected at the age of 1.5-2 years.

Plastic Operations. Plastic operations on the face constitute a considerable part of surgery.

Such operations are not infrequently performed for the purpose of correcting inborn defects (harelip), defects and cicatrices remaining after inflammatory diseases (lupus, noma), and after removal of tumours.

Plastic operations are also performed for extensive deforming defects and cicatrices on the skin of the face, especially if they prevent the eyes, mouth, etc., from closing; these operations consist in covering the defects with flaps of skin taken from some other part or flaps on pedicles taken from distal parts, for example from the hand, or by free transplantation of strips of epidermis.

DISEASES AND INJURIES OF THE JAWS AND THE ORAL CAVITY

Surgery of the jaws and oral cavity is a branch of stomatology. Since the soft tissues of the oral cavity and the tongue are richly supplied with blood vessels, injuries to these tissues are often accompanied by profuse hemorrhages and usually become infected because of the presence of virulent microbes in the oral cavity. Infections of wounds in the floor of the mouth run a very severe course and are accompanied by an ichorous discharge.

Dislocations of the Lower Jaw (luxatio mandibulae). Dislocations of the lower jaw occur, particularly in elderly people, as a result of their opening the mouth too wide (for example, when yawning), hard blows at the lower jaw, etc. The picture of dislocation is quite characteristic—an open mouth and inability to close it, protruding chin, and retraction of the capitulum mandibulae anteriorly of the helix. Dislocations of the lower jaw are reduced as follows: the patient is seated on a low stool and an assistant holds his head; the surgeon places his thumbs on each side of the masticatory surface of the large lower molars and grasps with the other fingers the outer edges on each side of the lower jaw. By gradually but strongly pressing downward on the teeth he brings the capitulum mandibulae out of its abnormal position on the articular tubercle of the jaw in which it rests under the action of the muscles; after this the jaw is shifted somewhat posteriorly, although it usually suffices to press the jaw downward for the capitulum spontaneously

to enter the articular fossa. It should be remembered that in this case the jaw closes forcefully and may injure the one who is reducing the dislocation, for which reason it is necessary to wrap the fingers in gauze beforehand.

Fracture of the Jaw. Injuries to the jaws (fractures), the upper as well as the lower, are most frequently accompanied by simultaneous injury to the mucosa and infection of the focus of the fracture.

Particularly grave are bullet wounds in the jaws attended with considerable injury to the soft tissues and fragmentation of the bones. This region sustains about 8-10 per cent of all the injuries.

Symptoms. The considerable destruction of bone and extensive injuries to the soft tissues characteristic of bullet wounds in the jaws often accompanied by coma create the erroneous impression that these cases are hopeless.

Characteristic signs of fracture of the jaw are improper closure of the teeth and intense pain on attempts at closing them. In these cases the mouth is half-open, there is abundant salivation, an elongated face, edematous soft tissues and hemorrhage under the conjunctiva.

Treatment. Aid for injuries to the jaws consists in arresting the hemorrhage, ensurance of normal respiration, reposition of the fragments and their retention in the proper position, and prevention of infection.

Hemorrhages are arrested by tamponing or by grasping and ligating the vessel in the wound. Respiration is rendered difficult by the blood flowing into the respiratory tract, but most frequently by retraction of the tongue.

During primary bandaging (for transporting the patient) in cases of injury to the lower jaw and difficulty of respiration (retraction of the tongue), as well as for the purpose of preventing this complication, it is necessary to pull out the tongue. To do this, the tongue is punctured at the tip with the safety pin found in the first-aid packet and a strip of bandage is tied to the safety pin. The bandage is fastened to the patient's clothing (on the chest). Another method may be used; it consists in puncturing the tip of the tongue, pulling a silk thread through the puncture and fastening the thread to the patient's thumb with his arm in a sling (Fig. 237).

Unconscious patients must be transported with the head turned to a side; if the patient is conscious, it is best to transport him in a semi-sitting position, thoroughly wrapping up his head in winter.

Subsequently, in cases of simultaneous injury to the floor of the mouth, respiratory difficulty may arise and asphyxia may develop owing to edema of the vocal cords.

Preliminary treatment during the dressing of the wound consists in removing the foreign bodies and superficial free fragments of bone. Following this the wound is dressed. First aid for fractures of the jaw consists in temporary immobilisation by means of a wooden tongue depressor or piece of board (Fig. 238). In fractures and injuries of the lower jaw immobilisation is achieved after reposition of the fragments by application of curved wire splints to the teeth. These wire splints connect

Fig. 237. Fixation of the tongue

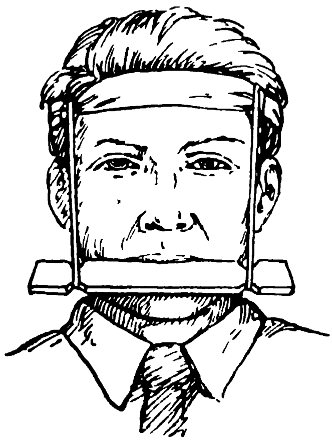


Fig. 238. Improvised splint bandage for fracture of the upper jaw

the teeth of the fragments with those of the unaffected part of the jaw (Fig. 239).

Subsequently the patients require special and rather complicated treatment consisting in application of special splints and prostheses and administered only by stomatologists.

Care of patients. Since the patients cannot rinse their mouths themselves and find it difficult to swallow, care of these patients consists mainly in repeatedly rinsing their oral cavity with disinfecting solutions of potassium permanganate, hydrogen peroxide, etc., from a rubber balloon during the day and night, otherwise stagnation results in the oral cavity, the saliva and mucus decompose, the wound becomes infected, and a putrefactive odour from the mouth appears. Rinsing the oral cavity and frequent changes of the dressings prevent these complications.

The splints are disinfected with 2 per cent hydrogen peroxide solution.

The patients are fed through a catheter introduced through the lower nasal passage (Fig. 240). This method, at first ap-

pearing difficult, proves very convenient and simple when properly employed. The patients are given food usually twice a day, the drinks and liquid food (milk, sweet tea, broth with a scrambled egg) being administered each time in doses of 2-2.5 glassfuls and sometimes more. The catheter is at first sterilised, coated with sterile vaseline oil and introduced through the right or left nostril (the one through which air passes more easily). While this is being done the tip of the nose is slightly raised and the catheter is conducted along the lower wall of the lower nasal passage in a horizontal direction; the catheter must glide absolutely freely. When it enters the pharynx, the patient may tend to vomit, for which reason he is asked to swallow, the catheter continuing to be inserted. If the catheter happens to enter the mouth it must be slightly withdrawn. The same thing must be done if attacks of asphyxia or coughing appear. After introduction of the catheter a check-up is made to see if it is in the proper position, whether the patient has a soundless voice and whether or not the air goes out through the catheter during respiration. If everything is in order, a funnel is placed into the external end of the catheter and a small amount of water is poured in. If the water does not flow into the funnel, the catheter must be slightly withdrawn or, on the contrary, inserted deeper and turned. If the catheter is in a correct position, the water will run through it rapidly and sometimes in spurts. Then the food that has been prepared is gradually poured into the funnel. When the feeding is over, the catheter is rinsed with water again and removed.

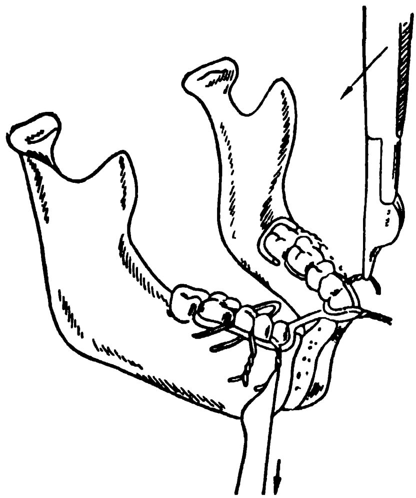


Fig. 239. Wire splints for the lower jaw and instrument for twisting the wire

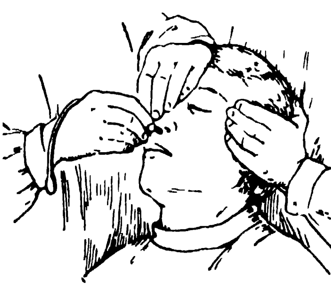


Fig. 240. Introducing a feeding catheter through the nose

Subsequently, and in milder cases soon after injury, it is

necessary to teach the patient to use the feeding cup or a funnel with a rubber tube attached to it. The tube is introduced into the mouth through the spaces between the teeth and splints or behind the dental arch to the level of the posterior third of the tongue.

Liquid is administered carefully so that the patient may have enough time to swallow it.

Approximate menu: a glass of milk and 25g of sugar in the morning; tea with milk, 25 g of sugar and one raw egg for breakfast; mashed-potato soup, thin semolina, and jelly for dinner; a glass of milk and a raw egg for supper.

Various sets of instruments are used for operations in the oral cavity and on the jaws, depending on the character of the operation (only on the soft tissue or on the bones as well).

If the operation is performed under general anesthesia, a sterile mask is used, and the anesthetist must make sure not to infect the operative field. In a number of cases intermittent anesthesia is administered for such operations, i.e., the anesthetic is given until the patient falls asleep at which time some part of the operation is quickly performed; as soon as sensitivity returns, the operation is discontinued and anesthesia is administered again. Local anesthesia or one of the forms of noninhalation anesthesia (intravenous hexobarbitone, rectal narcolan anesthesia) is even more convenient for operations in the oral cavity and on the face in general. The patient must not be totally anesthetised so that he may be able to expectorate or swallow the blood flowing into the pharynx; during total anesthesia with extinction of the reflexes the blood may gain entrance into the trachea and cause asphyxia or severe pulmonary complications. For this reason it is more convenient to operate on the face and jaws with the patient in a semi-sitting position. Postoperative care of the patients is considerably complicated by the impossibility of feeding them through the mouth. In such cases the patients are fed as during fractures of the jaws.

Inflammatory Diseases of the Periosteum of the Jaws. The infection spreads from the teeth and periodontium to the periosteum of the jaws, resulting in purulent inflammation with involvement of the submucous tissue. This disease is usually called parulis. It is manifested in pain, swelling of the gum, and pyrexia. Within a few days the abscess ripens and opens spontaneously (if it is not opened surgically).

In cases in which the infectious process involves the entire bone, acute osteomyelitis of the jaw develops and sequestra, fistulas, etc., are formed.

Inflammation of the periosteum of the jaw may be prevented by timely treatment of affected teeth. Parulis is treated with heat, i.e., rinsing with a hot tincture of sage (one teaspoonful

per glass) and hot compresses, and antibiotics. In most cases it is thus possible to prevent formation of an inflammatory infiltrate and abscess.

If a purulent focus has formed, it is best to open it. The tooth which has caused the disease is usually extracted.

Operations in the oral cavity are necessitated not only by injuries and inflammatory diseases, but also by a number of other processes: improper development, such as inborn cleft palate, and all sorts of tumours, for example sarcoma or cancer of the jaw.

DISEASES OF THE TEETH

Diseases of the teeth and oral cavity occur very frequently. They owe their development primarily to poor oral hygiene, but the general state of health is also of some importance. Depending on the state of the whole organism diseases of the teeth may run a more acute course and may quickly involve a number of teeth. Moreover, a defective tooth may serve as an antrum through which infection gains entrance into the organism.

Dental Caries. Dental caries is a widespread disease. In addition to oral hygiene, the character of nutrition and the temperature of the food, occupational factors and the physiological state of the organism (old age) also play an important part in this disease. The molars are most frequently affected. The disease begins with dissolution of the enamel and ends in destruction of the teeth. Microorganisms penetrating into such teeth take part in the process and subsequently gain entrance into the pulp where they cause inflammation (pulpitis).

During the carious process the teeth are sensitive to chemical, mechanical and thermal stimuli. In pulpitis spontaneous pains of a gnawing character arise and sometimes spread over the entire jaw, or the ear, temple, etc. The pains may be very intense and may last for a long time. Pulpitis may result in gangrene of the pulp and its putrefactive decomposition. The treatment of caries consists in cleansing the cavity and filling the affected tooth. Pulpitis is treated by mortification of the pulp with an arsenous paste, removal of the pulp tissue and filling the tooth.

To alleviate the pains, phenol solution with cocaine or other tooth drops are used; the drops are introduced into the cavity of the carious tooth on a small cotton ball (after first removing the remnants of food from the tooth).

Periodontitis. Not infrequently the inflammatory process extends from the tooth to its periodontium. This disease is called periodontitis.

In its acute stage periodontitis is characterised by pain upon pressure on the tooth and a certain looseness of the tooth. During

a purulent process the pus is sometimes discharged through the root canal to the exterior; in some cases it breaks through the gum or from under the gum thus bringing the patient relief. In diffuse periodontitis intense gnawing pains are noted, especially upon any contact with the tooth, swelling and redness of the gum at the affected tooth, pyrexia, etc. Treatment of acute purulent periodontitis consists primarily in establishing an outflow of the pus. If there is a filling, it is removed and the pus is drained through the canals. The affected tooth is extracted.

In chronic periodontitis fungiform granulation tissue grows at the apex of the root (granuloma). Treatment of chronic periodontitis boils down either to disinfection of the root canals, removal (resection) of the root apex or extraction of the tooth.

Teeth are extracted with special forceps under local anesthesia with a 1-2 per cent novocain-adrenalin solution and observance of all rules of asepsis.

Hemorrhage Following Tooth Extraction. Bleeding after extraction of teeth is one of the frequent complications. It is intensified as a result of improper action, namely, extrusion of the blood clot with the tongue, rinsing, etc. It is best to hold a 3 per cent hydrogen peroxide solution in the mouth (without rinsing); tamponade of the dental alveolus, placement of a small roll of gauze between the teeth, the patient compressing the roll with his teeth, and, lastly, suturing the edges of the gum, are all useful. In rare cases it is necessary to resort to general measures aimed at enhancing coagulation of the blood.

DISEASES AND INJURIES OF THE SKULL AND ITS CONTENTS

Craniocerebral surgery is one of the most serious and important branches of surgical work. This chapter deals with injuries to the skull and brain and their consequences, inflammatory diseases of the brain (cerebral abscess), tumours of the skull, the brain and its meninges and a number of other diseases.

Cerebral Hernia (encephalocele). Newborn children sometimes have hernia in front, in the region of the bridge of the nose, or in the rear, in the occipital region. The tumours are covered with skin, but communicate with the content of the cranial cavity through defects in the cranial bones. If the hernial covering is so thin that it may rupture, an urgent operation is required. If the hernial sac breaks and a light cerebrospinal fluid is discharged at the point of the break, a voluminous aseptic bandage must be applied and the child must be immediately referred for surgical treatment. The operation consists in a plastic closure of the bone defect.

Concussion of the Brain (commotio cerebri). In contusions of the head, for example blows on the head, the head striking

against the pavement during a fall in the street, a fall from a height, etc., very frequently no injuries to the skull are found, but the patient develops a characteristic picture of concussion of the brain.

Concussion of the brain is a more serious result of trauma. At the moment the injury is sustained or immediately after it the patient loses consciousness. He produces the impression of a person who is fast asleep, breathes evenly and deeply, answers no questions and does not react to light stimuli. This condition is frequently accompanied by vomiting and involuntary urination. It lasts several minutes, half an hour, and sometimes longer. Then the patient gradually recovers consciousness, but feels generally weak and dizzy, and has a headache and buzzing in the ears. It is characteristic that after regaining consciousness the patient cannot recall what happened. Complete unconsciousness at the moment the injury is sustained, vomiting and amnesia (loss of memory) are the most characteristic signs of concussion of the brain.

First aid in concussion of the brain. After the patient has regained consciousness he must be ensured complete rest for a longer period of time and must be administered sedatives (morphine, bromides, Asratyan's solution, etc.).

Contusion of the Brain (contusio cerebri). In contusions of the brain multiple hemorrhages are observed at points corresponding to the site of the blow or on the opposite side. In addition to hemorrhages, crushing of the brain substance with subsequent softening of its tissue is possible. The picture of the disease at first resembles that of concussion of the brain, but the phenomena do not disappear within a few days as they do in cases of concussion of the brain, but increase, and focal symptoms appear (pareses, paralyses, convulsive twitchings). Contusions of the brain run different courses depending on the localisation and extent of destruction of the brain tissue. The treatment and care of patients are generally the same as in concussion of the brain. Phenomena of compression of the brain indicate surgical treatment.

Fractures of the Skull (fractura cranii). Injuries to the skull involving fractures of its bones run a severe course. Two main types of fractures of the skull are distinguished: fractures of the *vault* of the skull and fractures of the *base* of the skull. Fractures of the skull are sustained particularly frequently in street accidents (automobile accidents).

Injury to cerebral tissue, intracranial hemorrhages and development of infections of the brain and the meninges in cases of open fractures are the main danger of cranial fractures.

Fractures of the vault of the skull constitute 70 per cent of all the fractures of the skull and are either open or closed.

The fractures may occur in the form of cracks, fragmentary fractures and fractures with impaction. It should be remembered that even a slight crack and impaction of the outer table (Fig. 241, *a*) may produce considerable destruction inside the skull because the inner table of the flat cranial bones is impressed during fractures into the membranes, and the cerebral substance is injured more than can be supposed by the outer appearance of

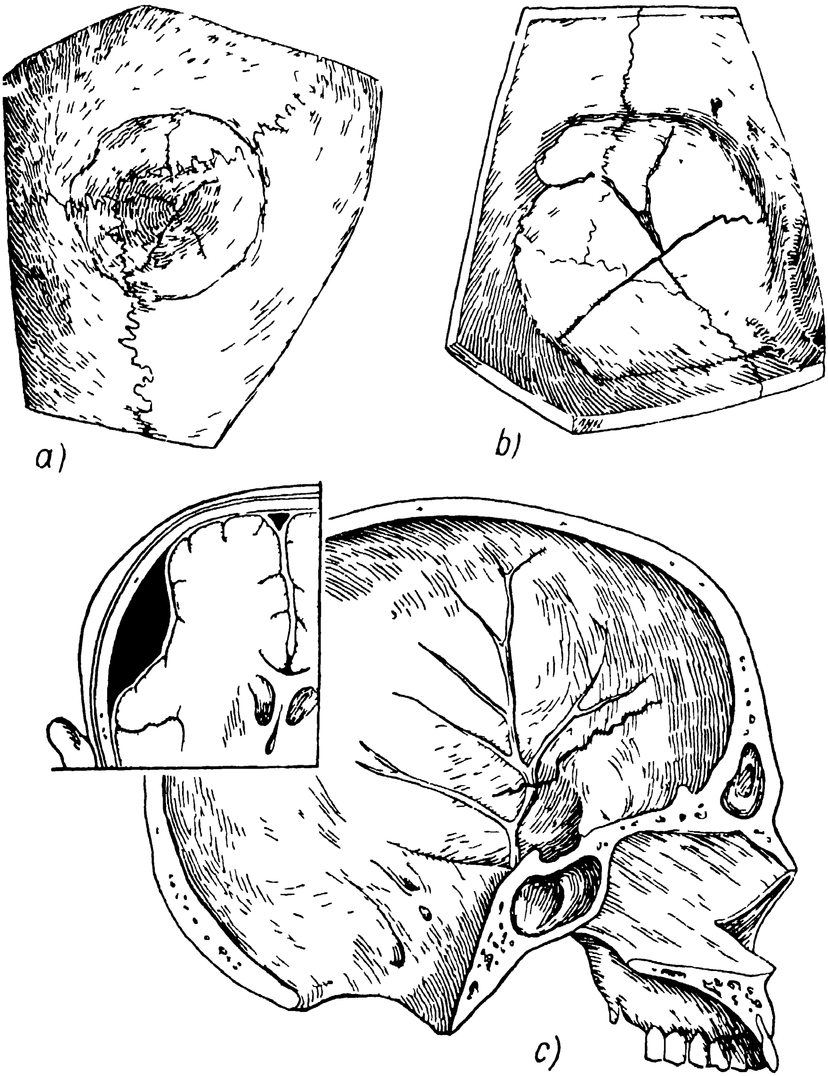


Fig. 241. Fracture of the vault of the skull and intracranial hematoma

the wound (Fig. 241,*b*). In such cases bony fragments are formed, pressing on the brain, breaking the meninges, arteries and the very brain tissue, and causing intracranial hemorrhages (Fig. 241,*c*).

In most cases of skull fractures the victims lose consciousness at the moment the injury is sustained; in some instances they remain unconscious for some time after sustaining the injury, vomit, have a slow pulse and other symptoms of concussion of the brain.

Examination of the skull does not always reveal the fracture because separate fragments, crepitant under pressure, are palpated under the skin or impactions are observed only in severe cases; most frequently, however, the examination discovers hemorrhages and determines pain by palpation. Fractures of the skull exhibit the following focal symptoms: loss of functions of certain portions of the brain, paralyses of the extremities, disturbances in ocular mobility, distortion of the face and disorders of speech. Sometimes the extent of injury to the skull may be judged only by a roentgen picture.

Injuries to the dura mater and intracranial hemorrhages are determined by a spinal puncture which yields a fluid with an admixture of blood. The puncture is also of therapeutic value since it reduces intracranial pressure.

Patients with fractures of the skull, even closed ones, should be treated only in the hospital. The patients need a restful position, ice to the head, and long confinement to bed. They must be carefully watched because an urgent operation may be required if brain compression develops or sudden intracranial hemorrhages occur. The following are symptoms of increasing intracranial pressure in typical cases: unconsciousness, clonic spasms, dilation of the pupils, vomiting and slow pulse.

Patients with fractures of the skull require close attention, especially if they are unconscious. In addition to the usual care, it is necessary to watch their skin in the sacral region because the patients may develop bedsores, especially since they not infrequently urinate and defecate in bed. In some cases such patients do not urinate at all and it is therefore necessary to drain their urine for a long time by means of a catheter, strictly observing all the rules of asepsis.

Danger of infection of the fracture focus and subsequently of the brain and the meninges is a specific feature of *open fractures* of the vault of the skull.

During examination of the wound in the skin of the skull the fracture of the latter is determined by the presence of bony fragments, cracks, and bony impactions in the wound, as well as pulsation in the depth of the wound, outflow of cerebral fluid and protrusion of cerebral tissue. In some cases, especially in minor wounds of the skin of the skull, it is difficult to establish

injury to the bone, and in these cases such injury must therefore be suspected. More precise data can be obtained only by special and roentgen examination.

In closed fractures of the vault of the skull involving no complications the patients are carefully watched and given conservative treatment, whereas in open fractures surgical treatment is, as a rule, required because of the danger of infection. Such patients must therefore be urgently delivered to a special medical establishment for an operation similar to those performed for injuries to the skull and brain (see below).

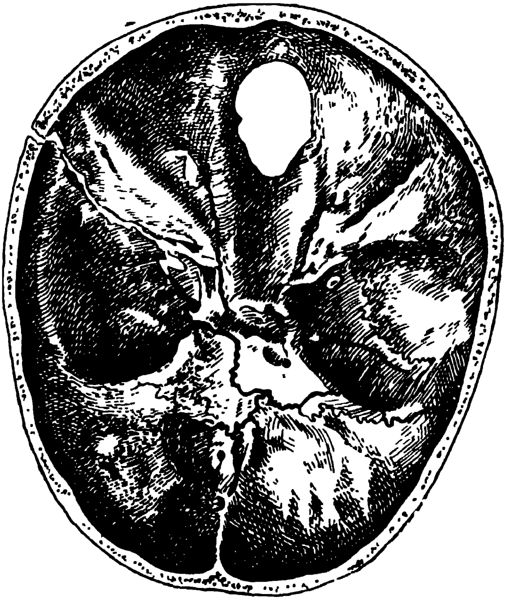


Fig. 242. Fracture of the base of the skull

Fractures of the base of the skull constitute 30 per cent of the cranial fractures and usually look like transverse cracks in its bones (Fig. 242). The specific feature of these fractures is that they involve injury to the meninges. The mucous membranes in the region of the pharynx, the oral cavity and the region of the middle ear, as well as the tympanic membrane, also rupture simultaneously. Thus, these fractures are most frequently open. Infection from the nasal cavity and the pharynx may gain entrance into the meninges and produce meningitis which constitutes the main danger of these fractures.

Symptoms. Unconsciousness and other symptoms of concussion of the brain are noted at the moment of the injury and soon afterwards.

The main signs indicating these fractures are bleeding and sometimes a discharge of cerebrospinal fluid from the nose, ear or mouth, paralyses of the cranial nerves, and hemorrhages under the conjunctiva. An accurate picture of the injury can be obtained by roentgenography. A lumbar puncture yields a fluid mixed with blood.

Treatment. The patient must be put to bed with an ice bag on his head, but must not be allowed to sit up. If the patient is unconscious, a lumbar puncture is desirable for the purpose of

reducing intracranial pressure. To prevent development of infection in the meninges, the patient is administered penicillin, other antibiotics, sulfonamides and urotropin (daily 2.0-4.0 of urotropin per os or 10 ml of a 40 per cent solution intravenously), and must be kept in bed for 3-4 weeks. If the patient is unconscious the medical personnel must see to it that he does not soil himself with urine and feces; they must prevent appearance of bedsores and watch the patient's pulse, respiration and temperature. If blood and cerebrospinal fluid ooze out of the ear, the latter must not be irrigated, but an aseptic dressing must be applied to the region of the ear. Nor must the nasal cavity be irrigated. The personnel must watch particularly carefully for the appearance of possible complications. The severest complications of fractures of the skull responsible for enormously high mortality are, as has been pointed out above, compression of the brain by intracranial hemorrhages and inflammation of the meninges.

With infection gaining entrance to the meninges the temperature rises, headaches and rigidity of the occiput develop, the patient loses consciousness and convulsions begin; lumbar punctures yield a turbid fluid. Such patients have to be particularly closely watched and tended.

Cerebral Compression. This is the most dangerous complication in any cranial injury. The picture of compression of the brain is most clearly manifested in intracranial hemorrhage (Fig. 241,*c*), but may also be conditioned by edema of the brain during its injury, as well as impaction and pressure of bony fragments in fractures. It is characterised by a gradual increase in the symptoms, sometimes after a certain lucid interval which follows the injury. The symptoms of cerebral compression are: headache, vomiting, restlessness, constriction and then dilation of the pupils, absence of reaction to light, slow pulse, wheezy breathing, sleepiness and unconsciousness. Cerebral compression not infrequently reveals focal symptoms.

It should be firmly remembered that, owing to intracranial hemorrhage, symptoms of compression appear, as a rule, not immediately after the trauma, but after a certain uneventful period which may last from several hours to several days (in cases of so-called secondary hemorrhages). It follows that all patients with injuries to the skull, even the slightest injuries, must be kept under most careful medical observation for several hours immediately following the injury. Numerous accidents show that very frequently patients with severest intracranial injuries felt quite satisfactory or had the most insignificant symptoms (slight vertigo, nausea, etc.) during the first hours after the injury. If insufficiently experienced physicians failed to attend to such patients, the latter suddenly died soon afterwards with symptoms of compression of the brain. Even those persons who are discharged

in a satisfactory condition a few hours after the injury must be instructed to return to a hospital the moment the slightest symptoms appear. These instructions must also be given to the people in the patient's immediate surroundings.

The first aid to be administered for cerebral compression is surgical elimination of the compression. Ice is temporarily applied to the patient's head and sometimes hypertonic solutions (5 ml of a 40 per cent urotropin solution, 20 ml of a 40 per cent glucose solution, 10-20 ml of a 10 per cent common salt solution) are administered intravenously.

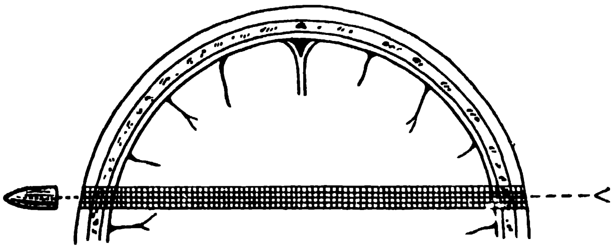


Fig. 243. Diametrical wound of the skull

Cranial Wounds (vulnus cranii). One of the most frequent and severe injuries to the skull and its contents is an open injury (wound). Such injuries occur in street and industrial accidents, and are particularly numerous in wartime.

Bullet wounds in the skull are some of the most important injuries as regards both their frequency and severity; they may be tunnel and blind wounds.

Tunnel wounds are divided into tangential, in which the bullet canal runs near the cranial wall, and diametrical, in which the canal runs into the interior of the skull, to its centre, and parallel to its base either longitudinally or transversely (Fig. 243).

The distinguishing characteristic of skull wounds is that they are extremely grave. Rifle bullets wounding the skull at short distances (no more than 100 m) inflict very severe injuries to the brain because its substance is semi-liquid. The cranial bones spring cracks running from the wound of entrance in the direction of the wound of exit (Fig. 244). The cranium suffers particularly great changes at the point of the bullet's exit, the wound of exit usually having mangled edges and being larger than the wound of entrance.

As the bullet passes through the brain it bruises the cerebral tissue and causes its subsequent necrosis and softening around the wound canal.

Owing to edema of the cerebral tissue and increase in the amount of the cerebrospinal fluid in the ventricles, the cerebral substance protrudes through the wound (prolapse of the brain). The softened cerebral substance is not infrequently discharged through the wound. The healing is very slow because cerebral tissue is scarcely able to form granulations.

Symptoms. Persons sustaining cranial wounds usually lose consciousness at the moment the injury is sustained; later, consciousness frequently returns, but sleepiness or excitement, vomiting, paralyses, slow pulse and a number of other nervous

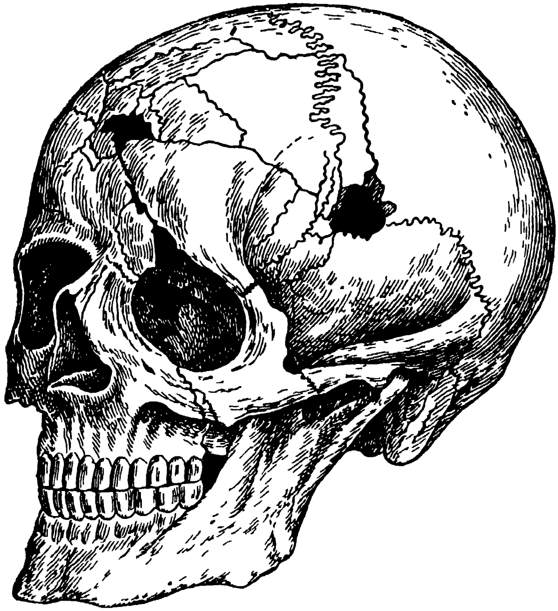


Fig. 244. Gunshot comminuted fracture of the skull

phenomena (disorders on the part of the sense organs, etc.) may appear.

In cases in which there is a large wound and palpable or crepitant fragments of bone are found in or around the wound it is not difficult to diagnose an open skull injury. In other cases the diagnosis may be made on the basis of the position of the wound canal (which can be determined by mentally connecting the wounds of entrance and wounds of exit), the outflow of cerebrospinal fluid, prolapse of cerebral substance from the wound and pulsation of the blood which fills the floor of the wound.

Sometimes it is very difficult to decide whether the injury is one only of the cranial integuments or it also involves the cra-

nial bones and the brain because the aforesaid symptoms of injury to the skull and brain may at first be absent. A diagnosis must therefore be made on the basis of careful examination and observation.

To prevent infection of the meninges and the brain during injuries to the skull, *first aid* consisting in application of a dressing must be administered as early as possible. Before application of the dressing the hair must be clipped and the skin around the wound painted with iodine tincture. It is still better to shave the hair around the wound, covering the latter with sterile material and shaving away from the wound without lathering the head. Because of the pain suffered by the patient the latter is sometimes shaved before the operation when he is already under anesthesia. In cases of prolapse of the brain the latter must not be repositioned. In cases of considerable bleeding a pressure bandage is applied.

The patients must be transported in a position with the head raised so that it is not shaken during transportation. In injuries to the brain it is very important to ensure most rapid and most convenient transportation (air transportation is the best) so as to deliver the patient to a medical establishment as soon as possible, because in cases of injury to the skull the best results are produced by early surgical treatment. If the patient is unconscious and breathes with difficulty (retraction of the tongue), it is necessary to eliminate the danger of asphyxia by ligating the tongue.

The operation consists in cleansing the wound and removing the bony fragments, trephining the skull, arresting the hemorrhage and removing the crushed cerebral tissue. During the first days after the operation the patient must not be transported. In wartime it is therefore best to transport patients with cranial wounds before the operation.

Subsequent treatment, if the wound has been left open, consists in dressings, the latter being made very carefully so as not to injure the prolapsing cerebral tissue. The wound usually heals very slowly: the prolapsing cerebral substance is drawn in but gradually and the wound fills out with granulations rather late. If the dressing is soaked in cerebral fluid, it is necessary to apply more dressing material. Since infection inevitably gains entrance into the wound from the hair and skin at the moment of injury, brain wounds are always considered infected. Infection may cause inflammation of the meninges (meningitis), an inflammatory process in the cerebral tissue (encephalitis) and an abscess of the brain, which are very dangerous to life.

The following are symptoms of developed infection, which are usually manifested several days, and rarely several weeks, after the injury: pyrexia, coma (if the patient happened to regain his

consciousness after the injury), convulsions, sometimes excitement or complete prostration. Death often ensues very soon.

Care. Patients with injuries to the brain are given the same care as those who are unconscious. The patient's head is placed on the side opposite to the wound and is surrounded with pillows or sand bags. The mouth and skin, especially that on the back, must be kept particularly clean, the latter being rubbed down every day; urination and evacuation of the bowels must be very carefully watched; in cases of urinary retention the urine is drained with a catheter. The sides of the bed are protected with nets or sheets because in his state of excitement the patient frequently jumps up and performs forceful movements, and may therefore fall off the bed. After recovery persons with cranial wounds sometimes retain nervous phenomena (paralysis, epilepsy, etc.) which incapacitate them. In some cases these defects subsequently require surgical treatment.

Cerebral Abscesses. A local purulent process in the cerebral tissue (abscess) develops as a result of infection gaining entrance into it during injuries to the brain. But an abscess may also develop as a result of infection penetrating from a purulent focus on the head (purulent processes of the cranial integuments, inflammation of the middle ear, purulent inflammation of the mastoid process) or being brought with the blood stream from some distant purulent focus (for example, from a pulmonary abscess).

In cerebral abscess the picture of the disease is not always clear because of the depth of the process and the peculiarities of its course. The temperature may be high, slightly elevated or normal. The changes in the blood usually indicate an inflammatory process (increased leukocytosis, shift to the left and a high erythrocyte sedimentation rate).

An abscess of the brain is usually accompanied by considerable general cerebral phenomena (headaches, slow pulse, sometimes impaired vision, unconsciousness, etc.) and focal cerebral symptoms indicating affection of some part of the brain (paralyses, disorders of the sense organs, etc.).

Abscesses of the brain take a very severe course and the prognosis is often unfavourable. Treatment is surgical, although it is not easy precisely to establish the location of the abscess. After an operation usually consisting in trephining the skull and opening the abscess, the latter is drained.

The care of these patients is the same as that of unconscious patients suffering from cranial injuries. The patients are placed in a restful position with ice applied to the head.

Trephining the Skull. Surgery is the only method of treating most of the foregoing diseases. The technique of trephining

differs from the other operations considerably. It was very thoroughly elaborated at the Burdenko Central Neurosurgical Institute.

Trephining is resorted to in injuries and fractures, in cases of pressure on the brain following various injuries to the skull (skull defects), and in abscesses and tumours of the brain, hydrocephalus, etc.

Clinically it is possible to classify as brain tumours the tumours deriving from cerebral tissue (gliomas, gliosarcomas), intracranial tumours of the nerves, tumours deriving from membranes and tumours of the bone if they press on the brain.

The symptoms of cerebral compression and elevated intracranial pressure include persistent headaches, vomiting, slow pulse, impairment and then loss of vision (symptom of papilledema during examination of the fundus oculi).

For trephining the patients are prepared as for any major operation. Shaving the hair on the head is a serious factor. The head must be shaved very carefully so as not to injure the skin in the morning before the operation because small cuts may become infected and thereby interfere with the asepsis of the operation.

Trephining begins with an incision of the skin, most frequently in the form of a flap; the periosteum is moved aside and the skull is opened in several places with special drills, after which the bony bridges between the holes are nipped with bone-cutting forceps or are sawed. The most important part of the operation, i.e., the operation on the cerebral tissues and meninges, begins after opening the skull. Before this part the operative field is usually encircled with towels again and the instruments are replaced.

The bleeding from the cranial bones is arrested by compressing these bones with sterile wax; the hemorrhage from the brain and meninges is arrested by irrigation with hot (40-50°C) physiologic saline solution which must be prepared beforehand. After the operation on the brain the dura mater is sutured with thin stitches (preferably with catgut), the removed piece of the skull is put back in its place and the skin is also sutured.

The postoperative care of these patients is serious and complex. In some cases the patients are unconscious for several days after the operation. It is necessary to watch carefully that the patients do not develop bedsores; it is also necessary to drain their urine (strictly observing all the rules of asepsis), continuously to keep ice on the head, and administer intravenously hypertonic solutions of glucose and urotropin several times per day. If they fail to regain consciousness for a long time, they have to be fed like little children. If a patient is greatly excited and jumps off the bed, he must be restrained, and sheets or nets must be

fastened to both sides of the bed to prevent him from falling on the floor.

During the days immediately following the operation it is necessary particularly carefully to watch the pulse which may become tense and slow, indicating cerebral compression by intracranial hemorrhage or cerebral edema. After the operation the patients may also die of acute anemia caused by extensive loss of blood, and of shock produced by severe injury to the nervous tissue during the operation. Lastly, the postoperative course of the disease may become aggravated by a purulent infection of the meninges (meningitis) which is manifested in pyrexia, headaches and then unconsciousness, inability to touch the chest with the chin (rigidity of the occiput) and a number of nervous phenomena.

INJURIES AND DISEASES OF THE NECK, TRACHEA AND ESOPHAGUS

Wounds of the Neck. Owing to the presence of large blood vessels (carotid artery, jugular vein) and vital organs (trachea, esophagus, etc.) in the neck, the injuries to the latter are very dangerous. If an artery is injured, extensive hemorrhages threatening the patient's life are possible; injury to the common carotid and subclavian arteries is particularly dangerous. In these cases first aid consists in application of pressure to the arteries and subsequent rapid delivery of the patient to a medical institution for ligation of the injured vessel.

The common carotid artery is pressed with the thumb or the four other fingers to the transverse processes of the cervical vertebrae at the medial edge of the sternocleidomastoid muscle.

The subclavian artery is pressed against the first rib over the clavicle on the borderline between its internal and middle thirds. The artery may be compressed by drawing the corresponding arm of the patient downward and backward, in which case the artery is compressed between the clavicle and the first rib.

In injuries to the large veins of the neck (jugular and subclavian) air may be sucked in through the central end of the vein, which leads to air embolism and death. The aid to be administered consists in immediate compression of the vein in the wound followed by its surgical ligation.

Injuries to the esophagus are usually manifested in difficulty of swallowing and sometimes bleeding from the mouth. They are also attended with severe infection of the wound. An inflammatory process develops near the esophagus, extends to the mediastinum (mediastinitis) and usually ends lethally. When injury to the esophagus is suspected, the patient must completely abstain from taking food and drink by mouth and must not swallow even saliva; the wound has to be opened surgically. In some cases the injured esophagus is sutured.

The usual instruments employed in operations on the soft tissues are also prepared for this operation; a gastric tube is added.

After the operation the patients have to be fed through a feeding tube or a gastric fistula made surgically for this purpose.

Injuries to the trachea are also dangerous because together with the air a lot of blood gains entrance into the trachea and is likely to cause asphyxia. Moreover, the small outlet creates a danger of compressing the organs with the air coming out of the trachea (subcutaneous emphysema). Subcutaneous emphysema is characterised by an appearance of a swelling on the neck; the swelling rapidly enlarges and spreads to the face, chest and over the whole body. Pressure on the swollen skin produces crepitation.

In addition to the foregoing complications, there is also a danger of asphyxia owing to edema of the rima glottidis.

First aid in injuries to the trachea consists in swift delivery of the patient to a medical institution for urgent surgical intervention. If the patient breathes through the wound, no dressing must be applied; instead of a dressing a wet gauze curtain must be placed on the neck. In cases of respiratory difficulty a tracheotomy tube may be inserted in the trachea through the wound. To facilitate expectoration of the blood which flows into the trachea, the patient should be transported in a sitting position with head inclined forward, or on his side, but never on his back.

In cases of open wounds the hemorrhage should be arrested by ligation of the bleeding vessels.

In early operations the prognosis is relatively favourable. Subsequently such patients require careful attention because edema of the rima glottidis may lead to respiratory disorders necessitating a tracheotomy.

In addition to the aforesaid organs, injuries to the neck may involve the nerves of the brachial and cervical plexuses and the spinal cord; these injuries are characterised by paralyses and other nervous disorders.

Lymphadenitis and Phlegmons of the Neck. Various purulent diseases occur on the neck. Carbuncles are not infrequent on its posterior surface and purulent inflammations of the cervical lymph nodes on the anterior and lateral surfaces. Infection gains entrance into the lymphatic vessels through the tonsils, the oral cavity or from purulent processes on the face. The nodes along the anterior edge of the sternocleidomastoid muscle are most frequently affected. The purulent processes on the neck are noted for their tendency to spread along the cervical organs (esophagus, vascular bundle) into the thoracic cavity. To prevent such spread requires vigorous early surgical intervention. It should be remembered that during a purulent process on the neck, which has an extensive vascular network, the walls of the vessels may be corroded by pus and may start bleeding. Drains must not be left in cervical wounds for a long time because they foster formation of decubitus ulcers of vessels, which may also cause bleeding.

Another complication of the purulent process on the neck, which must not be overlooked, is respiratory difficulty owing to edema of the rima glottidis. The aid administered during this complication requires the same treatment as is usually administered for tracheal stenosis, i.e., a tracheotomy and early incision of the purulent focus.

Phlegmon of the floor of the mouth, which usually extends to the neck, is a peculiar and at the same time very severe and dangerous disease. It is known as Ludwig's angina. Symptoms: dense swelling under the lower jaw, pyrexia, grave general condition and general septic phenomena. The disease develops very rapidly, the swelling descends to the neck and may cause respiratory difficulties (edema of the trachea).

After early and vigorous surgical intervention, even before formation of an abscess, the disease takes a milder course.

Tuberculosis of the Cervical Lymph Nodes (tuberculous lymphadenitis). This very frequent disease is localised in the supraclavicular region, namely, in front and in back of the sternocleidomastoid muscle under the lower jaw. It is observed mainly in children. Clinically it begins with an enlargement of the lymph nodes. After enlarging, the nodes, which are almost painless and are palpated as a chain during this period, merge and form clusters; the tubercular foci decompose, dissolve and give rise to very painful abscesses. The abscesses open spontaneously and form fistulas with cyanotic edges, sluggish granulations and a considerable amount of liquid pus. They heal very slowly.

The treatment of this disease is the same as that of tuberculosis in general, phototherapy being administered locally; during decomposition of the nodes punctures are made and an iodoform emulsion, or preferably streptomycin, is administered into the focus. Incisions are made only in cases of additional secondary purulent infection. Usually, the patients do not have to be confined to bed.

Goiter (struma). Goiter is a *disease of the thyroid gland* involving its enlargement.

In some areas (for example, in Switzerland, and in the Soviet Union—the Caucasus, Urals, Altai and other, mainly highland, regions) goiter occurs frequently and among broad sections of the population (endemic goiter). Its endemic character is apparently connected with the drinking water, especially with its deficiency and consequently, the organism's deficiency, in iodine salts.

In addition to endemic goiter there are also individual cases of goiter in different areas (sporadic goiter).

The enlargement of glandular tissue in this disease is of a nature of real hyperplasia of the organ; depending on the degree of development of the particular tissue the goiter may be parenchy-

V.

matous (hyperplasia of the glandular substance proper), fibrous (connective tissue), vascular and colloid (with a large accumulation of the glandular secretion). Goiter may be diffuse, encompassing the whole gland, nodular, in which case only a certain part of the gland is affected, and combined. Sometimes goiter grows to enormous size.

Symptoms. The main symptom of goiter is a swelling clearly visible on the neck; it is situated medially from the sternocleidomastoid muscles and shifts during swallowing (Fig. 245,*a*). The swelling begins to compress the cervical organs and to ren-

Fig. 245,*a* Goiter

Fig. 245,*b*. Basedow's disease

der respiration difficult only when it develops to considerable size. In endemic areas where goiter sometimes develops in early childhood a disturbance in the function of this gland involves profound mental changes (cretinism).

The prophylactic measures which prevent the appearance of goiter in endemic areas include, in addition to improvement of the general hygienic conditions and supply of good drinking water, long-continued administration of small doses of iodine salts added to the common salt used by the population. The thyroid gland may become enlarged without disorders of its endocrine function, although its enlargement often entails intensification of its function.

Basedow's Disease (thyrotoxicosis). In this form of goiter the enlargement of the gland, which sometimes may not even be particularly great, is accompanied by profound disturbances in internal secretion. This disease is most frequently sporadic. A psychic trauma very often serves as an etiologic factor. The patients (mostly women) exhibit tachycardia, hidrosis, tremor of the hands, exophthalmos (Fig. 245,*b*), extreme weakness,

emaciation, irritability, impaired memory and sharply increased basal metabolism.

The therapeutic treatment of this disease consists in administration of small doses of iodine, methylthiouracil and radioactive iodine. If this treatment fails to produce good, permanent results, surgical treatment is resorted to; the latter is more effective if it is administered early.

Surgical treatment of goiter and Basedow's disease consists in partial resection of the gland. Patients with simple goiter are prepared for operations as usual and require no special care, whereas those suffering from Basedow's disease are given special preparation for the operation, i.e., they are administered small doses of iodine (from one to fifteen drops of iodine tincture in milk three times a day) or Shereshevsky's pills for a period of 2-3 weeks.

The operation is usually performed under local anesthesia, especially in cases of Basedow's disease, and requires the usual instruments employed for operations on soft tissues and a large number of hemostatic clamps; in severe cases of large and malignant goiters a set of instruments for tracheotomy is added.

Care. After the operation the patients must be kept in a half-sitting position to prevent the tissues of the neck from straining and to facilitate respiration. The heart must be carefully watched because of the possibility of sudden death after operations for Basedow's disease. Moreover, operations on goiter may be followed by hemorrhages from the wound; simultaneous mistaken excision of the parathyroid glands may result in spasms (tetany). Treatment of the spasms consists in administration of calcium salts (10 per cent solution of calcium chloride in doses of one tablespoonful) per os.

Myxedema. This disease of the thyroid gland accompanied by *diminution of its function* produces in adults a picture of myxedema (wrinkled and dry skin, loss of hair and teeth, lowered metabolism, apathy, fatigue, headaches and cessation of the menses). Retarded development and sluggish metabolism is observed in children; in milder cases the weakening of the function of the gland in childhood is manifested in mental underdevelopment, low learning ability and poor growth.

Treatment. In this disease, as generally in cases of low thyroid functioning, administration of thyroidin in a dose of 0.1-0.3 three times a day is indicated.

Laryngeal Stenosis (stenosis laryngis). In some cases constriction of the lumen of the larynx is observed; this produces a grave clinical picture (stenosis). In adults stenosis occurs in tuberculosis and tumours of the larynx, in inflammation of the laryngeal cartilages, typhus, edema of the vocal cords, and a number of other diseases, as well as in operations and traumas on the neck.

The first symptom of laryngeal stenosis is increasing respiratory difficulty. The patient becomes uneasy, breathes with a peculiar wheeze and inhales noisily. Owing to the insufficiency of air entering the lungs during inhalation, the jugular fossa, intercostal spaces and hypogastric region are retracted. A cyanotic colouring of the skin and lips appears because of an oxygen deficiency in the blood. Asphyxia sometimes occurs suddenly, in attacks, during sleep, and sometimes increases gradually. The picture of laryngeal stenosis is most characteristic in children affected with croup.

As soon as the first signs of increasing laryngeal stenosis appear the intermediate medical personnel must summon a physician because the disease sometimes progresses very rapidly. As a temporary measure, it is recommended to give the patient a hot foot bath (one teaspoonful of mustard, the temperature of the water 43°C), apply mustard plasters to the calves, administer an inhalation and put the patient in a half-sitting position. While this is done, everything that is necessary for a tracheotomy and intubation is prepared. Laryngeal stenosis necessitates a tracheotomy.

Tracheotomy. The essence of this intervention consists in opening the trachea through an incision of the neck along the midline and insertion of a tube (tracheotomy cannula) into the trachea (see Fig. 65), the patient breathing through this cannula. Sharp and blunt retractors, a scalpel, a tenaculum for holding the trachea, a tracheal dilator, tracheotomy tubes of different sizes, hemostatic instruments, needle holder and needles, silk, novocain solution and a syringe are prepared for the tracheotomy.

After the operation the tracheotomy tube remains in the wound, a strip of gauze is placed under it and a small gauze bib is made over it. To prevent the tube from slipping out, it is fastened to the neck by a strip of gauze. The nurse must be able to handle the tube, i.e., to take out its internal inserting part and reintroduce it after cleansing it of the mucus.

The inserting part is taken out as follows: the tube is held in place and the pin in the upper part of the tube shield is turned so that it comes over the slit of the internal tube. After this the internal tube is easily removed if pulled by the shield.

Before the tube is boiled it must be cleansed of the adhering mucus. The internal surface of the tube must be washed and cleaned with particular care by pulling a probe with a piece of gauze through it.

Tracheotomised patients require careful watching since they may develop respiratory difficulties not only because of obstruction of the internal tube, but also for other reasons, the most serious of which are a falling-out of the tracheotomy cannula and subcutaneous emphysema.

If air enters the subcutaneous tissue, bypassing the tube after a tracheotomy, subcutaneous emphysema develops and renders respiration difficult. Subcutaneous emphysema may be discovered by the appearance of a swelling, crepitant under pressure, in the region of the neck. It is necessary to summon a physician immediately in order to open the wound and insert the tube properly. The other complication—falling-out of the cannula from the trachea—is characterised by difficulty of breathing, the air no longer entering or coming out through the tube. This complication also requires urgent summons of a physician.

Fig. 246. Esophagobronchoscopy

Foreign Bodies in the Respiratory Tract. Not infrequently foreign bodies gain entrance into the respiratory tract, especially in children. During inhalation, laughter, fright, crying or talking any object which happens to be in the mouth may penetrate into the respiratory tract under the vocal cords and usually cannot come out. Pointed foreign bodies, for example fish bones, are sometimes retained in the trachea, whereas other foreign bodies usually penetrate deeper and may enter the large bronchi.

The things most frequently found in the respiratory tract are sunflower seeds, and less frequently—nutshells, buttons, beads, fish and meat bones, pins, tacks, paper clips, and all sorts of small things which children, and sometimes even adults, take in their mouths. Immediately after a foreign body has found its way into the respiratory tract, the patient develops an attack of asphyxia and coughing. Sometimes a foreign body produces no other symptoms; in other cases the respiratory disorder continues and is manifested in dyspnea, cyanotic colouring of the integuments and from time to time attacks of coughing.

In such cases the disease very frequently takes an unfavourable course, especially in children; a number of grave complications in the lungs appear and, if the foreign body is of considerable size, death due to asphyxia may ensue. The foreign body must therefore be removed from the respiratory tract as soon as possible.

Foreign bodies are removed by a special instrument—bronchoscope. The mucosa of the pharynx and larynx is painted with a 5 per cent dicaine solution (in children under general anesthesia), the tube of the bronchoscope is introduced through the mouth into the trachea and after examination the foreign body, thus found, is removed through the tube (Fig. 246).

DISEASES OF THE ESOPHAGUS

In addition to injuries to the cervical part of the esophagus discussed above, injuries to its intrathoracic part are also possible; these are injuries with still graver infections, which soon end lethally, especially since they are usually accompanied by injuries to other thoracic organs.

Foreign Bodies in the Pharynx. Pointed foreign bodies, mainly fish bones, gaining entrance into the pharynx usually get stuck in the tonsils. In such cases patients feel a stinging pain, especially when swallowing, and point at the precise location of the foreign body. Examination of the pharynx and pressure on the tongue with a tongue depressor or spoon reveal the bone sticking in the tonsil, and the bone can be easily extracted with a forceps or other similar instrument. It should be remembered that frequently, after going through the pharynx and injuring it superficially, the foreign body gains entrance into the stomach and even further, while the patient retains only a sensation that the foreign body is still at the point of injury.

Foreign Bodies in the Esophagus. The things which most frequently gain entrance into the esophagus are meat and fish bones. During rapid eating such large bones sometimes penetrate into the esophagus that it is a wonder the patient did not notice them. Not infrequently small objects—coins, plum pits, buttons, etc.—gain entrance into the esophagus, especially in children. Lastly, false teeth and large soft pieces of food (meat, pieces of apple, etc.) also get stuck in the esophagus.

On entering the esophagus a foreign body usually produces a characteristic picture. The patient feels that something is stuck in his throat and finds it difficult to swallow; sometimes even liquid fails to go through and is ejected by vomiting. In cases in which large bodies penetrate into the esophagus the patient not infrequently develops respiratory difficulties and asphyxia, almost always feeling a pain at the point where the foreign body got stuck, or a shooting pain in the back. The pain is particularly sharp if the pointed bodies stick in the esophageal wall. The results vary with the character of the foreign body. Smooth and not very large bodies may pass into the stomach, whereas pointed bodies not infrequently perforate the esophagus and cause

purulent infection of paraesophageal cellular tissue which often ends lethally. The prognosis is serious in all cases. The foreign body must be removed from the esophagus as soon as possible.

If a soft or hard but not pointed foreign body has got stuck in the pharynx, an attempt to remove it with a finger may be made. The vomiting motions developing in such cases aid in removing the foreign body. Sometimes the patients are given water (if they can swallow), liquid food or an oily gruel to help push the foreign body through into the stomach. If the bodies in the esophagus are large or pointed, the patient must be sent to a hospital for an esophagoscopy. The mucosa of the pharynx and esophagus is painted with a 5 per cent dicaine solution, after which an esophagoscope with a large-diameter tube is introduced into the esophagus and the foreign body is removed through the tube with forceps.

Stenosis of the Esophagus. Stenosis of the esophagus is a very severe and not infrequent disease. Cicatrisation after burns with concentrated acids or alkalis sustained by the esophagus serves as the main cause of stenosis. The stenosis is progressive and in the end even water ceases to pass through the esophagus.

Systematic bouginage of the esophagus after a burn is a preventive measure. Treatment of esophageal stenosis also consists in systematic bouginage.

In cases of total esophageal obstruction a fistula is made in the stomach (gastrostomy) to feed the patient. The instruments used in laparotomies, intestinal clamps and a medium-diameter drainage tube are prepared for gastrostomies.

During the first day such patients are usually given no food either by mouth or through the drainage tube. From the second day on small portions (50-100 ml) of liquid food (broth, milk, eggs, oils, cream, etc.), are introduced through a funnel into the drainage tube which remains in the fistula. It is necessary to feed the patients frequently (every 2-3 hours). The amount of food introduced into the stomach is increased only on the 6th or 7th day (1-2 glassfuls at each feeding). Subsequently it is very important to teach the patients thoroughly to masticate their food, spit it in its ground form, moistened with saliva and sometimes with some other fluid, into the funnel and thus introduce it into the stomach through the fistula. If the patient learns to eat in that manner, he may be prescribed a general diet. In such cases the patient not only ceases to lose weight, but on the contrary gains weight. In cases of total esophageal obstruction a plastic operation on the esophagus is performed.

Cancer of the Esophagus. Cancer of the esophagus is a very frequent disease. It is observed mainly in the middle and lower thirds of the esophagus, i.e., in its thoracic part, above or directly at the point of its passage through the diaphragm. Cancer

produces a stricture which embraces the esophagus circularly and reduces its lumen. Sometimes a cancerous tumour (scirrhus) completely obstructs the lumen of the esophagus. In the process of its development the cancerous tumour decomposes and ulcerates. The developing tumour extends to the trachea and mediastinum, affects the lymph nodes of the mediastinum and produces metastases into the liver and other organs. Usually, however, the patients do not live long enough for these complications to develop.

Cancer of the esophagus most frequently affects men (80-90 per cent) at the age of 50-60 years. Of the etiological factors conducive to development of cancer mention is made of irritation of the esophageal mucosa with alcohol, hot food and substances which, in cases of smokers, get into the saliva from the smoke.

Symptoms. The main symptom of cancer of the esophagus is *dysphagia*, i.e., difficulty in swallowing. At first the patient has difficulty only with solid food and must therefore drink after each swallow and change to a more liquid diet; subsequently liquid food also begins to pass through the esophagus with difficulty. The patient starts regurgitating small amounts of food and coughs after swallowing. Pains are added to the difficulties in the passage of food at first during swallowing; then they become constant, irrespective of eating. The patient notes the appearance of a viscous mucus which he cannot swallow. Owing to the disturbances in swallowing the patient loses weight, becomes emaciated, and the skin acquires an earthy pallor typical of cancerous cachexia. Sometimes a temporary improvement in swallowing is observed in connection with the decomposition of the tumour. A clear picture is produced by roentgenoscopy of the patient swallowing a barium sulphate suspension (of the consistency of heavy sour cream); the screen shows the barium to be detained at the point of constriction of the esophagus; a dilation of the esophagus is usually noted above the tumour. Accurate data are yielded by esophagoscopy during which it is possible to cut off under visual control a piece of tumour for histological examination (biopsy).

Treatment. Cancer of the esophagus was but recently considered an incurable disease. Since Professor A. Savinykh has elaborated methods of surgical treatment of tumours of the cardiac part of the esophagus, and professors V. Kazansky and B. Petrovsky have worked out methods of treating surgically the thoracic part of the esophagus, operations of the esophagus are now performed by many surgeons. Radiation treatment of cancer of the esophagus is also used. However, the basic method of treating cancer of the esophagus today is surgery.

In neglected forms of cancer—cancer of the middle third of the esophagus—roentgen therapy is employed.

Both radical and palliative operations are performed. In radical operations the affected portion of the esophagus is excised with subsequent production of an esophago-gastric anastomosis or replacement of the esophagus with a piece of the small intestine. In cases in which a radical operation is impossible (total obstruction of the esophagus so that even liquid food cannot pass through it) a palliative operation is performed, i.e., a gastric fistula is made.

Premedication of patients for radical operations is very important because these patients are usually emaciated, dehydrated and most frequently elderly. For a period of 7-8 days the patients are daily administered a 5 per cent glucose solution or up to 2-3 litres of physiologic saline solution. Part of the physiologic saline solution may be administered by rectal drip. The patients are given blood and plasma transfusions, intravenous injections of glucose with ascorbic acid and vitamin B_1, and cardiacs.

The operation is performed by a left thoracic approach through the 6th, 7th or 8th intercostal space.

Care. During the first 5-7 days after the operation the patients are usually in a grave condition. A swift and complete stretching of the lung is required. This is achieved by continuous suction through a drain from the pleural cavity. During the first 3-4 days the patient must neither eat nor drink. The lack of fluid is compensated by intravenous and subcutaneous injections of glucose solutions and by rectal drip, the lack of nourishment—by transfusions of blood and blood substitutes.

After gastrostomies for cancer of the esophagus the patients require the same general and dietary regimen as do patients gastrostomised for stenosis of the esophagus. It is necessary to watch very carefully that the gastrostomy tube does not slip out, especially during the first days after the operation. Gastric juice not infrequently trickles out to the exterior near the tube and irritates the skin. To avoid this, it is necessary to protect the skin around the tube with a paste or ointment. Within two weeks a canal is formed, and during dressings the tube may be removed for washing and boiling, and then reintroduced.

Although the disease is very severe and responsible for high mortality, it can no longer be considered hopeless; in cases of early diagnosis surgical treatment produces satisfactory results. The patients must be referred to a surgeon as early as possible.

INJURIES AND DISEASES OF THE THORAX AND THE THORACIC ORGANS

Fractures of the Ribs (fractura costae). Fractures of the ribs may be caused by injuries to the thorax sustained in falls, compression of the thorax, etc.

Particularly dangerous are injuries to the ribs resulting from lateral compression of the thorax. In such cases the fragments of the broken ribs penetrate into the thorax and lacerate the pleura and lungs.

The *symptoms* of rib fractures are: sharp pain during respiration, shallow respiration, pain on pressure at the point of the fracture, tense thoracic muscles, constrained movements, and frequent painful and intense attacks of coughing. The fractures are dangerous only in cases of injuries to the lungs (blood in the sputum, phenomena of internal hemorrhages, subcutaneous emphysema, etc.).

In uncomplicated cases of costal fractures it is quite enough to apply a tight bandage to the thorax (adhesive plaster, gauze, towels, etc.) and simultaneously (to relieve the pain and coughing) to administer narcotics (Codeini phosphorici 0.015 per os, and Morphini hydrochlorici 0.01 subcutaneously).

To relieve the pain and facilitate respiration, it is necessary to inject into the area of the rib fracture a 1 per cent novocain solution and sometimes to follow it by an injection of alcohol.

An adhesive plaster bandage may be used for a costal fracture. A strip of plaster 5 cm wide is applied obliquely, the strip being tightly stretched along the broken rib from the spine to the anterior midline. The bandage is applied during expiration. Sometimes several more strips of plaster are applied parallel to the first strip, above and below it. An ordinary gauze bandage is applied on top of the plaster bandage so that the plaster may not come off and may not stick to the clothing. In multiple fractures novocain is injected behind the sternocleidomastoid muscle (vagosympathetic block).

Care. Patients with fractured ribs must be confined to bed. They have to be kept in a quiet half-sitting position. It is necessary to see that their intestines function properly and to give

them enemas or laxatives to facilitate defecation. Such patients not infrequently have pulmonary complications. To prevent the complications and improve their respiration the patients are given narcotics. Patients who sustained an injury to the pulmonary tissue during the fracture of the ribs require particular care because the disease may be aggravated by pneumonia and pleurisy.

Injuries to Thoracic Organs (vulnus thoracis) also occur in peacetime. In wartime they are caused by bayonet thrusts, dagger stabs, bullets and shell splinters.

The gravest injuries to the thoracic cavity are those involving the pleura, lungs, heart and major vessels. Most of the patients sustaining injuries to the heart and major vessels die.

In injuries to a lung or intercostal arteries blood begins to accumulate in the pleural cavity (hemothorax) and impairs respiration and the cardiac function.

Injuries to the thorax are accompanied not only by hemorrhages, but also by penetration of air into the pleural cavity through the wound or from the injured lung (pneumothorax). When the wound through which air has gained entrance is immediately closed, the pneumothorax is called a closed pneumothorax; when the air freely enters the pleural cavity during inspiration and comes out during expiration it is an open pneumothorax.

Since the lung collapses and is excluded from respiration in pneumothorax, in cases of bilateral open pneumothorax the patients usually die; death occurs the sooner, the greater the communication of the pleural cavity with the exterior.

In unilateral pneumothorax the size of the opening is of enormous importance; although the lung collapses when the opening is small, it still takes some part in respiration. The situation is much worse when the opening is large. In such cases the affected lung does not take any part in respiration at all, the inflow and outflow of air through the wound during respiratory movements cause the mediastinum to vibrate, which renders respiration of the intact lung difficult and gravely affects the blood circulation.

The picture is no less serious in so-called valvular pneumothorax in which the air enters the pleural cavity during inspiration through a wounded bronchus or through the wound and cannot come out from the pleural cavity during expiration. The air accumulates in the pleura compressing the lung on the affected side and crowding the mediastinum to the intact side; this simultaneously aggravates the disturbances in respiration (dyspnea) and blood circulation and leads to the patient's death. Another complication is also possible, namely, penetration of air into subcutaneous tissue; this produces a rapidly increasing swelling of the subcutaneous tissue which crepitates under pressure (subcutaneous emphysema).

Symptoms. In injuries to the thorax it is important to establish whether the wound penetrates into the pleural cavity or has only touched the superficial tissues (skin, muscles). This serves as the basis for diagnosis and treatment.

The following factors are important for the diagnosis of a penetrating thoracic wound: 1) location of the wound, 2) inflow and outflow of air and foamy blood through the wound (the wound "breathes, sucks and spits") during respiration, 3) coughing with sanguineous sputum and 4) attacks of asphyxia. To be sure, these signs are feebly pronounced in many cases, especially in bullet and incised wounds.

Treatment. In all cases in which injury to the thoracic cavity is suspected the patient must be rapidly delivered to the nearest medical institution, because such patients often have to be operated during the very first hours after the injury.

If the injury contains an open pneumothorax, it is necessary to prevent the air from entering the pleura during inspiration.

First aid to the injured with an open pneumothorax must consist in application of a massive bandage (preferably with vaseline) which tightly closes the point of injury and hinders the air from penetrating through the wound during respiration (occlusive dressing). The bandage may also be applied as follows: after the skin around the wound is coated with sterile vaseline or cleol the wound is covered with a strip of sterile rubber which is kept in place by a tight bandage. Lastly, to transform an open wound into a closed wound, its edges are sutured in some cases already during administration of first aid.

In cases of injuries to the thoracic cavity the patients must be ensured complete rest. Transportation is limited as much as possible. Many surgeons advise transportation of patients with thoracic wounds in a sitting position. Others, owing to the danger of air embolism, recommend transportation of the wounded in a recumbent position, the patients lying on the injured side.

During transportation the patients with thoracic wounds are administered the following aid. At first a bandage is applied by means of the first-aid packet; in cases of open pneumothorax the rubber bag of the first-aid packet may be used for an occlusive dressing.

Subsequently an occlusive dressing is applied, if it was not applied before, and is fastened with strips of adhesive plaster. Antishock measures and Vishnevsky's vagosympathetic block are administered. In cases of coughing the patients are given codeine. Then the dressing of the patients with open pneumothorax is corrected, the wound is covered with wide strips of adhesive plaster, and antitetanic serum is injected. If the patient

has hemothorax, the blood is pumped out. If the bleeding continues, it must be arrested.

The patients operated for open or valvular pneumothorax and suffering from abundant hemoptysis are hospitalised to bring them out of shock and to arrest the bleeding.

Subsequently the patients with thoracic wounds are sent to hospitals where they are kept until the danger of infection of the pleura has passed.

Care. To prevent complications, the patient has to be kept in a quiet, recumbent position. In cases of pneumothorax disorders of the cardiac function are not infrequently observed. If no measures to eliminate pneumothorax are taken in due time, the patient can die. A subsequent complication of thoracic wounds is purulent pleurisy.

In cases of respiratory difficulties, especially in patients with open pneumothorax, it is necessary to arrange respiration of oxygen. Valvular pneumothorax is indicated by increased asphyxia and a *decline of cardiac activity*. In such cases the air must be pumped out; most frequently such patients require an urgent operation.

Lastly, one of the possible complications of thoracic wounds is air embolism which is manifested in disorders of vision and speech, paralyses and unconsciousness. The patient is immediately placed in a position with the upper part of the trunk and head lowered, and measures are taken to improve the work of the heart (camphor, caffeine, digalen).

Spontaneous Pneumothorax. Sudden onset of acute dyspnea accompanied by a feeling of constriction in the chest, pallor and cyanosis, as well as a rapid and weak pulse is characteristic of penetration of air into the pleural cavity, i.e., of formation of spontaneous pneumothorax. The affected part is immediately excluded from respiration. The mediastinum is displaced towards the unaffected side and the diaphragm is crowded downward. Measures of aid: half-sitting position in bed, in cases of dyspnea and feeling of constriction—morphine subcutaneously, in severe cases—inspiration of oxygen, in cases of collapse—stimulants.

Blood Spitting (hemoptysis). Excretion of blood with the sputum or its expectoration during coughing is called hemoptysis. The amounts of blood excreted by the patients vary very widely —from blood streaks which colour the sputum to 200-300 ml and more. Blood spitting always produces a distressing impression on the patient himself, as well as on those around him, especially if it occurs for the first time.

The *causes* of blood spitting may be injurious and different diseases of the lungs which affect the pulmonary vessels during decomposition of pulmonary tissue: i.e., tuberculosis, malignant neoplasms and pulmonary abscesses; besides, pulmonary ves-

sels may become ruptured in cases of congestion in the lungs (cardiac diseases), sclerotic changes in the vessels and their fragility (hemorrhagic disease).

Symptoms. In the first place it is necessary to determine whether this is really blood spitting, because hemorrhage from the nasopharynx and nose and, in individual cases, vomiting of blood may be mistaken for blood spitting. Blood spitting is denoted in cases of pulmonary disease, excretion of blood mixed with sputum, or excretion of blood simultaneously with the sputum during coughing, and a sensation of tickling in the throat before hemorrhages.

Treatment. A blood-spitting patient needs primarily complete rest, both physical and mental. He must be put to bed with the upper part of his body raised. The clothing rendering respiration difficult must be removed. The room in which the patient is kept must be well ventilated and the air in the room must be cool. The patient must be prohibited all physical effort. He must be advised not to speak, to breathe calmly and, if possible, not to cough. He must be reassured by persuasion that the hemorrhage is not a dangerous and in no way fatal symptom. In cases of intense coughing narcotics are administered (morphine per os or subcutaneously in a dose of 0.005-0.01, dionine, heroin, codeine).

An ice bag or cold compresses may be applied to the patient's chest and hot water bottles or mustard plasters to the feet. During the days immediately following the hemorrhage the patient must be given only cold food and drinks. In cases of intense thirst the patient should be recommended to swallow pieces of ice. The medicines administered during pulmonary hemorrhages are substances which increase coagulation of the blood: Solutio Calcii chlorati 10.0-20.0:200 0, a tablespoonful 3-5 times per day or 5.0 of horse serum subcutaneously. At home a saturated solution of common salt may be given per os (in swallows) as a first-aid measure. To arrest bleeding and in cases of phenomena threatening general anemia blood transfusions are resorted to.

Pulmonary Abscesses. The purulent processes in the lungs (pulmonary abscesses and gangrene) may be unified in a single group because they have a great deal in common. A pulmonary abscess is most frequently caused by incompletely cured (unresolved) pneumonia, but infection may also gain entrance in another way, for example with the blood stream during injury. A purulent process in a lung produces grave morphologic changes, namely, impregnation of pulmonary tissue with pus, and its mortification (gangrene) and considerable inflammation of the surrounding tissues. Lastly, abscesses are formed. Some abscesses are drained through the bronchi, the abscess cavities shrink, close and the process ends in spontaneous cure. In other cases the

abscesses do not completely drain, their capsules grow thicker and they may exist for a long time producing grave changes throughout the system (amyloidosis, general emaciation). In some cases there are multiple abscesses.

It is difficult to diagnose an abscess before it communicates with the bronchi. The symptoms are mainly general: pyrexia and grave general condition. Discharge of a large amount of purulent sputum or sputum with an odour indicates that an abscess has opened into the bronchi. An exact diagnosis may be made by a roentgenological examination.

Many severe complications are observed in the course of an abscess; the most important of these are pulmonary hemorrhages (hemoptysis), extension of the abscess into the pleura and purulent pleurisy.

In the beginning pulmonary abscesses are treated conservatively, i.e., penicillin and other antibiotics are administered intramuscularly and through the trachea into the bronchi.

If the process has existed for more than a month and its elimination by therapeutic measures becomes doubtful surgical treatment is resorted to.

The operation is performed under local anesthesia. A rib is resected (first moment) and the wound is tamponed to make the lung adhere to the parietal pleura so that the pus may not gain entrance into the pleural cavity, and, lastly, the pulmonary abscess is opened and emptied (second moment). The cavity of the abscess is drained. It is best to drain it by means of an underwater drain. For this purpose a drainage tube brought to the exterior through the dressing is immersed in a bottle with some solution, for example mercury bichloride. Through such a tube the pus will flow into the bottle, while during inspiration the air will be unable to penetrate through the wound into the cavity of the abscess. Thus, the negative pressure in the lung at the moment of the inspiration is balanced by the pressure of the liquid rising from the bottle along the tube; this is important to accelerate the healing.

In chronic abscesses and bronchiectasis a lobe of the lung is now not infrequently excised (lobectomy) or the affected segment is removed (resection).

After surgical intervention the patient with a pulmonary abscess requires special care and a nourishing diet. It is necessary carefully to collect into a closed jar and measure the daily amount of sputum and pus and also closely to watch the patient (pulmonary hemorrhages are possible).

Purulent Pleurisy (pleuritis purulenta). *Etiology.* A purulent inflammation of the pleura may appear after pneumonia, in general purulent diseases, injuries to the pleura, as a complication following pulmonary operations, and in pulmonary tuberculosis.

Inflammation of the pleura is usually preceded by formation of a pulmonary abscess.

Purulent pleurisy may be encapsulated, limited to some part of the pleural cavity, and total, embracing the entire pleura on one side. Very severe cases of bilateral pleurisy are less frequent.

The most frequent causative agents of pleurisy are streptococci, staphylococci and putrefactive microbes in adults, pneumococci in children and the tubercle bacillus in both.

Pathologic anatomy. In the beginning the inflammatory process in the pleura is not infrequently serous; later the exudate becomes turbid; in such cases depositions of fibrin on the pleura appear and produce adhesions between the pulmonary and parietal pleura; lastly, the exudate becomes purulent and in some cases putrefactive, and gases with a sharp putrescent odour accumulate in the pleura (pyopneumothorax).

If a large amount of exudate accumulates in the pleura, the heart becomes displaced, and circulation and respiration are disturbed. These complications may cause the patient's death.

From the pleural cavity pus sometimes breaks through the thoracic wall and skin resulting in formation of a fistula.

During protracted purulent pleurisy dense depositions are formed on the pulmonary and parietal pleura, preventing expansion of the lung. Acute empyema may become chronic.

Symptoms. A purulent process in the pleura usually leads to a grave general condition and produces extreme intoxication. The temperature is high and with extensive fluctuations (drop in the morning and rise in the evening), the pulse is rapid, there is considerable leukocytosis (15,000-20,000) and the blood formula shifts to the left.

In cases of considerable exudation shallow respiration, dyspnea, cyanosis, and a rapid weak pulse are observed. The patient coughs and complains of pain in the chest. Examination of the patient and fluoroscopy reveal a fluid in the pleura (continuous shadow instead of the transparent tissue of the lung, dull percussion note, absence of respiratory sounds, and weakened egophony).

To determine the nature of the exudate, a puncture of the pleura is made.

Treatment. Treatment of tuberculous pleurisies in adults and pneumococcic pleurisies in children consists in repeated aspiration of the fluid by means of a puncture. Other purulent pleurisies are subject to surgical treatment. Tuberculous pleurisy and pneumococcic pleurisy in children are not to be treated surgically.

Puncture of the pleura and aspiration of the fluid. To establish the presence of fluid in the pleural cavity and to elucidate its nature, the pleura is punctured. A Luer or "Record" syringe is

used for the puncture. A thin needle is prepared for local anesthesia with a 0.5 per cent novocain solution; for a puncture it is necessary to boil, in addition to the syringe and usual needles, also a thicker needle, making sure beforehand that it fits the syringe.

The most convenient position of the patient for a puncture is sitting slightly leaning forward, arms behind the head. The puncture is most frequently made along the posterior axillary line under the 8th rib where the pleural exudate usually accumulates.

During aspiration of the exudate the general condition of the patient and his pulse must be carefully watched since the decreased pressure in the thoracic cavity may cause a diminution in cardiac activity. In such cases it is necessary to discontinue the aspiration and to administer caffeine subcutaneously. The fluid is not infrequently aspirated from the pleura by means of a usual 10- or 20-g syringe. A thin rubber drainage tube 10-15 cm long is set on the needle used for the puncture and is clamped by a hemostatic clamp. After the needle is introduced into the pleural cavity the cannula of the syringe is inserted in the end of the rubber tube, following which the clamp is removed. Each time before the cannula of the syringe is removed from the tube it is clamped so that no air may gain entrance into the pleural cavity through the needle.

Besides aspirating the fluid from the pleura, the latter is sometimes drained by means of a syphon drain. Under local anesthesia, by means of a trocar or a small incision in the 8th or 9th intercostal space a drainage tube is inserted in the pleura and fastened to the skin. The other end of the tube is inserted in a bottle filled with liquid (syphon drain), or a system of underwater drainage consisting of two bottles one of which has a tight-fitting plug with two tubes emerging from it, one tube being inserted in the pleural cavity, the other—in the second bottle where it is immersed in an antiseptic liquid (Fig. 247).

Care. After the operation an oil cloth is spread under the patient's back because the dressing is usually soaked in pus. The patient is placed in a half-sitting position. When the bottle is filled with pus the tube is shut off by a clamp and only then is the end of the tube taken out of the liquid. The amount of pus should be measured. Since the patient's condition continues to be grave after the operation, the patient needs good care.

Purulent pleurisy is usually accompanied by various complications mainly due to the further spread of the purulent process to the subdiaphragmatic region and the pericardium, as well as metastasis and formation of new foci. In cases of communication with the bronchi, late operations and wrong postoperative treatment the empyema may become chronic, the patient will

retain an unhealing pleural fistula and may require a very difficult operation—thoracoplasty.

Cancer of the Lungs. *Symptoms.* In the beginning of its development cancer of the lungs runs an uneventful course and is not infrequently discovered accidentally during prophylactic roentgenological examination.

Most frequently the patients note attacks of coughing which are difficult to treat, a slight rise in temperature, an appearance of sputum with an admixture of blood, loss of weight, general weakness and sometimes indefinite pain sensations in the thorax.

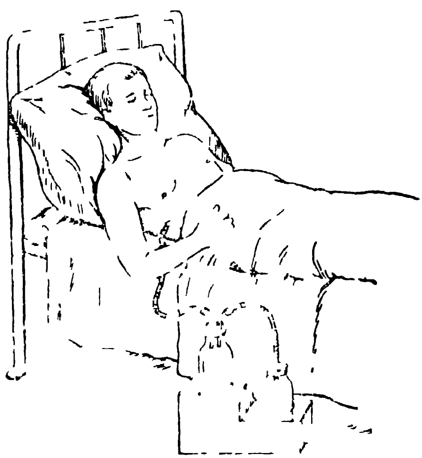


Fig. 247. Syphon drain

The conclusive methods of diagnosing cancer of the lungs are roentgenoscopy, roentgenography and special methods of examination: tomography and bronchography (roentgen pictures made with the use of lipoiodine, a contrast substance introduced into the bronchi).

If the general condition of the patient is satisfactory and there are no metastases of the tumour into the mediastinal organs, an operation is indicated.

Operations on the Lungs. The basic operations in the treatment of pulmonary diseases today are: removal of a lung (pneumonectomy) in cases of cancer of the lung, affection of the entire lung with bronchiectases and pulmonary gangrene; excision of a lobe of a lung (lobectomy) in cases of affection of a lobe with bronchiectases, abscesses and pulmonary tuberculosis, and the most economic operations in minor affections of pulmonary tissue (segmental pulmonary resections and wedge-shaped excisions).

The preparation of patients for these severe operations consists in preparation of the cardiovascular system and preliminary treatment with antibiotics during purulent processes in the lungs. On the eve of the operation the patients are given a bath, if their general condition allows it, and a hypnotic for the n ght (0.1 luminal or 0.1 sodium amytal).

The operation is performed under local anesthesia or under general intratracheal ether-oxygen anesthesia. The main stages of the operation are incision of the skin and muscles along an intercostal space or with an additional resection of the rib. After

opening the pleural cavity and slowly introducing air into it, the ribs are parted with a special dilator and a 0.25 per cent novocain solution is administered for blocking the reflexogenic zones. After detaching the lung from the adhesions, the bronchi and vessels of the root of the lung are detached in pneumonectomies, while the lobar and segmental bronchi and vessels are detached in economic resections and are ligated and transected. Of late special instruments have been very frequently used for suturing the bronchi and large vessels; these include the suturer of the

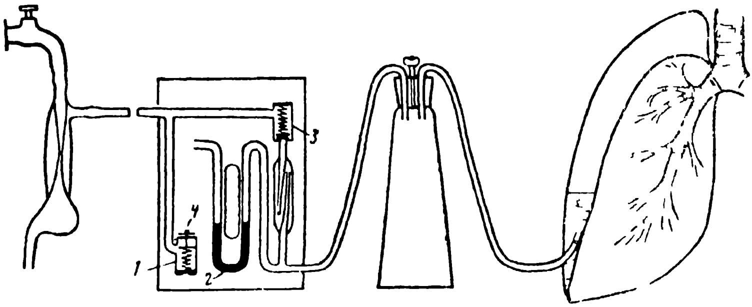


Fig. 248. Apparatus for draining by aspiration

bronchus stump and the suturer of the major vessels which automatically suture the vessels or bronchus with tantalum clips and make a good hermetical suture.

In cases of incomplete removal of the lung (lobectomy, segmental resection and wedge-shaped excision) a drain is introduced into the pleural cavity during the operation. After suturing all the layers of the thoracic wall, the air is aspirated from the pleural cavity through the drain and the remaining part of the lung is inflated until it is completely expanded.

After the operation these patients require particular care because, during the first few days, their condition continues to be grave. The patients must be kept in a half-sitting position, and their respiration and cardiac activity need constant and careful watching.

The gravest complications are pulmonary edema, pneumonias, bronchial fistulas and empyema of the pleural cavity.

During the first days after a pneumonectomy the exudate is aspirated from the pleural cavity by means of punctures, and antibiotics are administered into the pleural cavity. After partial resections of the lung continuous aspirational draining (aspiration of fluid and air) from the pleural cavity through a drain is established for 2-3 days.

An apparatus (Fig. 248) working from a water-jet pump under an assigned rarefaction is used for aspirational draining from the

pleural cavity. Aspiration of the fluid and air from the pleural cavity favours rapid expansion of the lung and obliteration of the residual cavity which prevents development of empyema.

During the first postoperative days the patients must be administered massive doses of antibiotics (penicillin and streptomycin) both intramuscularly and intrapleurally, cardiacs (camphor, caffeine, strophanthin with glucose intravenously), proserine, morphine or pantopon during pains. Moreover, it is necessary to arrange for the patients continuous respiration of oxygen.

CARDIAC SURGERY

Surgical treatment of cardiac diseases is a new and rapidly developing branch of surgery.

The diseases of the heart are regarded as most serious diseases because affections of the heart which is one of the most important human organs usually lead to changes in the other organs. Patients with congenital and acquired cardiac defects are subject to surgical treatment.

Congenital Cardiac Defects. Congenital cardiac defects are based on anomalies in the development of the heart. These defects are represented by a large number of combinations and are rarely observed alone. An open Botallo's duct (patent ductus arteriosus) and persistence of the oval opening between the atria (patent foramen ovale) are peculiarities of fetal blood circulation.

Towards the end of the first year of the child's life the opening between the atria closes and the arterial duct becomes obliterated. Sometimes the aforesaid defects persist in the child after the first year of life. In such cases these developmental defects lead to a mixing of the arterial and venous blood, which disturbs the normal supply of oxygen to the tissues of the organism and increases the load on the heart. As a result the heart gradually ceases to cope with the additional load, its functions are considerably disturbed and death ensues.

The surgical treatment of congenital defects consists in eliminating the extant developmental defects.

Persistent Botallo's Duct (patent ductus arteriosus). This congenital disease begins to be manifested towards the end of the first year of life and is completely revealed only towards the third year of life.

Patients with marked patent ductus arteriosus do not usually live past 24 years of age.

Symptoms. Complaints of stabbing pains in the region of the heart, especially during fast walking, dyspnea, rapid fatigability and subfebrile temperature due to additional septic botallitis (arteritis). These patients are noted for pallor of the skin and

mucous membranes. An exact diagnosis is made by special methods of examination.

Drug treatment is, as a rule, useless and almost 50 per cent of the patients die in childhood from decompensation of the heart or septic endocarditis. These patients can be cured of this disease and the great complications associated with it only surgically, i.e., by separating the aorta from the pulmonary artery.

The operation consists in ligation of Botallo's duct or its transection and suturing of the openings in the aorta and pulmonary artery. The operation completely eliminates circulatory disorders connected with the persistent Botallo's duct, and the conditions which favour development of septic endocarditis.

Persistence of the Oval Opening (patent foramen ovale). If the atrial septum has a defect, the blood gains entrance into the left atrium, circumventing pulmonary circulation, and is not oxygenated; this leads to cyanosis.

The operation consists either in suturing the minor defects with individual stitches or in closing the larger defects with homografts or plastic prostheses. These operations are most successfully performed with the artificial blood circulation apparatus (ABCA) on an open, so-called dry heart. In such cases it is possible completely to eliminate the defect.

Acquired Cardiac Defects. At the present time the greatest number of operations are performed on acquired cardiac defects. The most widespread cardiac operation is the operation on mitral stenosis.

Mitral Stenosis. Mitral stenosis is a constriction of the left atrioventricular orifice. This disease is most frequently caused by rheumatic infection which gradually leads to a shrinking of the cusps of the valve and its chordae tendineae. In such cases the cusps of the valve grow together and a stenosis of the orifice is formed, resulting in a circulatory disorder which depends on the extent of the constriction.

The symptoms vary with the stage of the disease. Usually the patients note general weakness, rapid tiring, dyspnea, periodic blood spitting, edema of the legs, enlargement of the liver and arrhythmia (disturbance of the cardiac rhythm).

The disease is divided into five stages. Operations are most frequently performed during the second and third stages and less frequently during the fourth stage if the general condition of the patient permits of surgical intervention.

During the fifth stage with marked decompensation (ascites, edema of the extremities and lumbar region) the inferior vena cava is ligated to improve cardiac activity.

Preparation for the operation On the eve of the operation the patient is given a cleansing enema, a bath and clean underwear, and 0.1 of luminal for the night. On the day of the operation the

hair on the chest and the left axilla is shaved off. The surgical treatment of patients with mitral stenosis is aimed at eliminating the constriction of the orifice.

The operation is performed under intubation ether-oxygen anesthesia with controlled respiration.

Operation. The thorax is opened by an incision along the fourth or fifth left intercostal space. An opening in the pleura and the pericardium is made, and then holders and a special clamp are

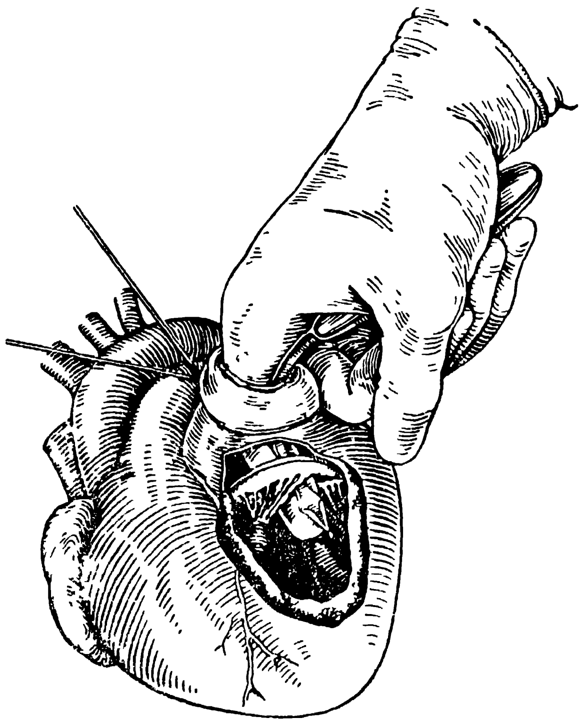


Fig. 249. Mitral commissurotomy

placed on the left auricle. After incision of the apex of the auricle, the clamp is gradually released and a finger is inserted in the heart (left atrium). Then the mitral opening is dilated by a separation of the commissures (the cusps of the valve) adhering as a result of the pathological process (Fig. 249). In cases of dense, fibrously altered rings the opening is dilated by means of a special instrument—commissurotome, and, if the ring of the mitral orifice is calcified, a valvulotomy, i.e., incision of part of the stenotic ring, is performed.

During the operation the patients are given blood or blood substitute transfusions. In addition to the operating surgeons

and the anesthetist, the patient's cardiac activity (by readings of the electrocardiogram) and oxygenation of the blood (according to the data of the oximeter) are watched by an internist.

Postoperative care of patients. After operations on the heart the life of the patients in large measure depends on the postoperative care and treatment. These patients require special care and constant close watching.

Care of the operated patients begins the moment they are put to bed. After anesthesia the patients are placed in a supine position, are given oxygen, and continuous aspiration (removal) of the fluid and air through the drain from the pleural cavity is arranged (see page 340).

After the operation it is necessary to devote particular attention to the state of the cardiovascular system and the organs of respiration. Every four hours the patients must be administered without fail one of the following preparations which tone up the cardiovascular system: camphor, cordiamine, caffeine, strophanthin with 40 per cent glucose intravenously, etc.

On the day following the operation the patient is placed, in the presence of the physician, on the bed with the upper part of the body raised, the legs half-bent and a bolster under the knees. At the present time special complex functional beds are used; on these beds any position may be imparted to the patient's body by turning special handles.

During the first 2-3 days the patient must continuously receive oxygen. For this purpose the postoperative wards are equipped with special oxygen installations or an oxygen cylinder with a reducing gear is placed at the patient's bedside. To prevent the oxygen from excessively drying and irritating the upper respiratory mucosa, it is moistened by being passed through water in the jar of Bobrov's apparatus. The moistened oxygen is fed either into a special mask or through a catheter which is inserted in the patient's nose and is fastened with plaster near the nostrils.

DISEASES OF THE BREASTS

The most important diseases of the breasts are inflammatory affections and tumours.

Mastitis. This purulent inflammation of the mammae usually occurs in women during breast-feeding. Acute and chronic mastitis are distinguished according to the course of the disease. The latter is characterised by pain and induration of the gland. Mastitis is of the greatest importance in cases of nursing women, most frequently primiparas.

The disease is favoured by the delicate skin of the nipple, its biting by the child, maceration of the skin, untidiness of the

breasts, appearance of cracks, excoriations and other affections of the nipple.

The *causative agents* of the disease are usual pyogenic microbes which gain entrance into the gland through small fissures and excoriations. The microbes penetrate deep into the tissues along lymph channels or lactiferous tubules. The milk secreted into the tubules stagnates, and the gland swells up; the milk casein coagulates and an infiltration appears in the interlobular tissue. Subsequently the process may develop reversely or, in grave cases,

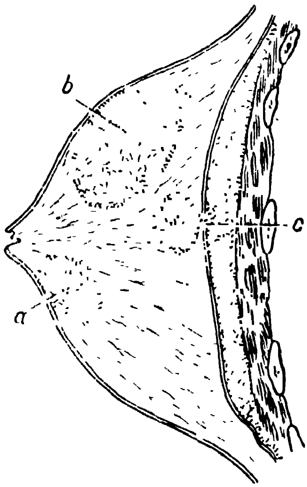


Fig. 250, *a*. Schematic representation of the variously localised accumulations of pus during mastitis
a—subcutaneous; *b*—within the mamma; *c*—behind the mamma

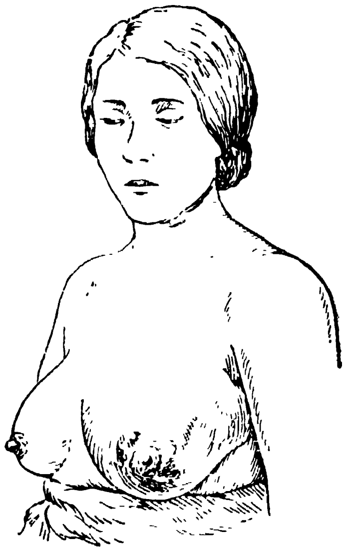


Fig. 250, *b*. Mastitis

into a rather deeply spread purulent disease whose course resembles that of an abscess or a phlegmon.

In the beginning of the process usually only one of the lobes of the mamma is affected, then the purulence extends to the adjacent lobes and new foci are formed.

A superficial purulent process, an abscess of a lobe, and suppuration in the subcutaneous tissue under the mamma are distinguished (Fig. 250, *a*) according to localisation.

Symptoms. The disease begins with a swelling, a feeling of tension, pain and induration in one of the lobes of the mamma.

The induration and swelling increase, the skin over the inflammatory focus becomes red (Fig. 250, *b*), and general feverish phenomena develop; the temperature sometimes rises to 39°C. Timely measures may in some cases cure mastitis without formation of a purulent focus. In other cases the phenomena increase, the temperature remains on a high level, chills develop and a dense infiltrate, which subsequently softens, appears. If the disease is left to its own course, it usually ends by an opening of the abscess and discharge of the pus to the exterior. But waiting for such an outcome not infrequently leads to extension of the process and threatens infection of the adjacent lobes of the gland and general purulent infection.

Treatment. The most expedient prophylactic measure against mastitis is extreme cleanliness and care of the nipples during pregnancy and especially during nursing; the nipples are washed with a boric acid solution before and after each nursing. In the beginning the treatment of mastitis consists in therapeutic measures. These measures most frequently include daily irradiation with a sun lamp (erythema dose), sometimes application of cold (ice) to the gland, and administration of antibiotics. Simultaneously the milk is usually drawn off or the baby is put to the breast.

To accelerate formation of an abscess, thermal procedures (hot water bottles, fomentations) are also administered.

Superfluous waiting favours the spread of the process, and the abscess must therefore be opened as soon as the signs of its formation appear (demarcation of the infiltrate, pyrexia, and redness of the skin). A radial incision running from the nipple to the periphery of the gland is most frequently made.

Care. During the first days, if the temperature is high, the patient must stay in bed. As soon as the temperature drops she is allowed to get up. The affected breast must be protected against any injuries and must be kept in a tranquil position (suspended by a properly applied bandage). After the incision moist antiseptic, hypertonic or ointment dressings are applied. If new foci are formed in the adjacent lobes of the gland repeated incisions are necessary.

Sometimes the process is aggravated by discharge of milk into the wound and formation of a mammary fistula.

In such cases, as well as in a diffuse process which encompasses a considerable part of the gland, aspiration of the milk and nursing are discontinued.

Cancer of the Breast. The breasts may be affected by benign tumours (fibroma, adenoma and fibroadenoma) and by cancer. Cancer of the breast holds second or third place among the cancerous diseases of women.

The cancer may arise on the skin of the breast and on the nipple, but it originates most frequently from the tubules of the gland

proper. In the beginning cancer of the breast represents a limited focus and remains a local disease, although usually it tends early to produce close and distant metastases.

Etiology and pathogenesis. As was already mentioned, the etiology and pathogenesis of cancer have not as yet been established. Cancer of the breasts occurs almost exclusively in elderly and

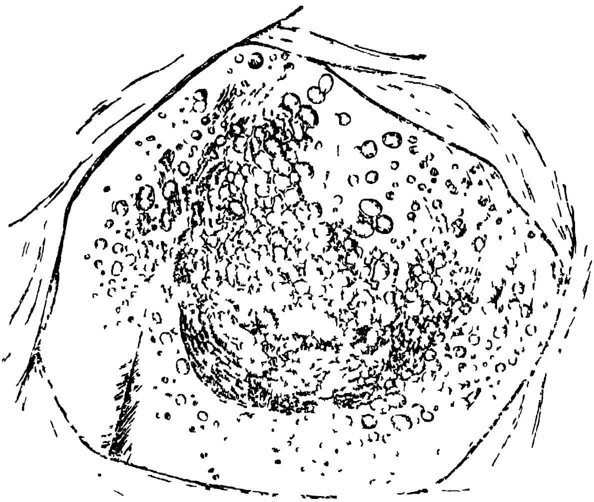


Fig. 251. Cancer of the breast. Dissemination through the skin

middle-aged women. The role of heredity in the origin of cancer of the breasts is doubtful. Many authors attach considerable importance to the role of acute and chronic trauma.

The importance of various disorders of the female sexual function (disturbances in the functions of the ovaries, microcyst degeneration of the ovaries, disorders of the menstrual cycle, abortions, refusal to nurse children, etc.) cannot be doubted.

Precancerous states. Certain benign affections of the mammae for some unknown reasons develop into cancer. These affections are called precancerous states. They include certain benign tumours, chronic mastitis and so-called secerning, i.e., producing a serous secretion and bleeding, mammae.

Symptoms. The clinical course of cancer of the mamma is usually divided into four stages.

Stage I. A small tumour (not larger than 2-3 cm in diameter) freely moving in the tissue of the mamma is palpated in the gland. The regional lymph nodes in the axilla are not enlarged and are not palpable.

Stage II. A similar or somewhat larger tumour freely moving in the tissue of the gland. One or two small, dense, movable lymph nodes are clearly palpated in the axilla.

Stage III. A tumour similar to that of the second stage is palpated in the breast, but packets of dense, enlarged lymph nodes are already clearly palpated in the axilla and the subclavicular region. This stage also includes the cases in which the tumour has grown through the skin, has become ulcerated or adheres to the fascia of the breast, while dense, enlarged lymph nodes are palpated in the axilla and subclavicular region. Lastly, Stage III also includes the small tumours combined with metastases to the supraclavicular or axillary fossae on the other side.

Stage IV. A large tumour which has grown through the skin, the underlying tissues, the pectoral muscles and ribs. This stage also includes the small tumour of the mamma combined with multiple metastases to lymph nodes or distant organs.

Cancer of the breast is difficult to diagnose because it is sometimes hard to distinguish it from the frequently occurring benign tumours.

The *symptoms* of the disease vary widely, depending on the stage of the disease. The diagnosis cannot be doubted during Stages III and IV of the disease, but is much more difficult and important during the initial stage.

During the initial stage of cancer pains are very rarely observed; they appear only in the presence of infection and at later stages; the pains become very intense when nerve trunks are involved in the process.

For final diagnosis in doubtful cases biopsy is resorted to, i.e., a portion of the tumour is excised for microscopic examination.

Treatment. In operable cases the basic method of treatment is early surgery.

The essence of the operation (amputatio mammae) consists in excision of the gland together with the skin, pectoral muscles, lymph nodes and subcutaneous tissue in the axillary region.

X-ray treatment is often administered in cancer of the breast. Preoperative irradiation is administered during Stage III and sometimes Stage II. Postoperative irradiation produces positive results and is administered in all cases of cancer of the breast.

The results of surgical treatment of cancer of the breast improve with each passing decade because of the improved surgical techniques and earlier application of patients.

The prophylactic measures consist in extensive propaganda of the necessity of taking early medical advice in cases of tumours of the breasts and excision of all benign tumours.

The postoperative *care* of patients with cancer of the breasts is the same as in all postoperative cases.

SURGICAL DISEASES OF THE ABDOMINAL WALL AND THE ABDOMINAL ORGANS

Abdominal Hernias. An abdominal hernia is a protrusion of the peritoneum in the form of a pocket (sac) through fissures and low-resistance places in the musculoaponeurotic part of the abdominal wall with subsequent protrusion of the viscera into the peritoneal sac. On the outside the hernia is covered with the skin. Thus it consists of a hernial sac, hernial ring and the contents (Fig. 252).

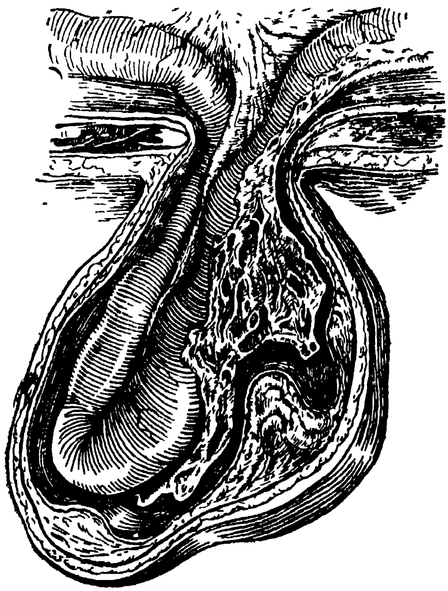


Fig. 252. Diagram of abdominal hernia with its component parts

A hernial sac consists of the peritoneum and is covered with the distended fascia and aponeurosis of the abdominal wall. The fissure in the abdominal wall through which the peritoneum protrudes is called the hernial ring or the gate, while the internal organs contained in the hernial sac, most frequently the omentum and loops of the small intestine, are called the hernia's contents. The hernial sac has a neck, body and floor. Hernia must be distinguished from prolapse in which the abdominal organs come out to the exterior through the wound in the abdominal wall, for example, a postoperative wound. Prolapses do not have hernial sacs.

Hernias most frequently occur in the inguinal, femoral and umbilical regions. An *inguinal hernia* descends through the inguinal canal into the scrotum and in females into the inguinal region; a *femoral hernia* descends in the upper part of the femur alongside the large vessel; an *umbilical hernia* is formed in the region of

the navel, and small hernias of the *linea alba* are formed along the median line of the abdomen. Lastly, *postoperative hernias* may form in any part of the abdominal wall, wherever there is a postoperative scar, especially in cases in which the healing occurred by second intention or tampons were inserted in the abdominal cavity. The reason for it is that a weak postoperative scar easily stretches. If the contents of the hernia can be replaced in the abdominal cavity, the hernia is called a *reducible* hernia. If the contents of the hernia cannot be returned to the abdominal cavity, the hernia is called an *irreducible* hernia. The irreducibility of a hernia is most frequently due to adhesions between the sac and the hernial contents or adhesions to each other of the intestinal loops found in the hernial sac.

Hernias are a rather widespread affection. They often occur in childhood and after the age of 25, most frequently in men, especially in the inguinal region.

Women, in addition to inguinal hernias, not infrequently have femoral and umbilical hernias.

Etiology. As was already mentioned, hernias protrude through the weakest parts of the abdominal wall. They may be congenital and acquired.

The appearance of acquired hernias is favoured by a number of factors among which predisposing and causative factors are distinguished. The predisposing factors are the anatomical peculiarities of the regions in which hernias appear and constitutional peculiarities. The latter include weak muscles, fascia and aponeurosis of the inguinal region (soft groin) and obesity of the abdominal wall which is responsible for its weakness.

Increased intraabdominal pressure, for example, when lifting heavy weights, serves as a causative factor. When heavy weights are lifted, the pressure in the abdominal cavity under certain conditions rises, the viscera press against the abdominal wall and in connection with this a fissure is formed in its weakest part. The fissure gradually expands and the peritoneum begins to protrude through it; this protrusion may subsequently increase. Following the peritoneum the internal organs also enter the hernial sac. In addition to weight lifting, the intraabdominal pressure may be increased by chronic coughing, constipation, urinary difficulties, etc.

Symptoms. Reducible hernia yields the clearest clinical picture. The patient notes unpleasant sensations and pain in the region of the hernial sac, the pain particularly increasing during walking and working, owing to the penetration of the hernial contents into the hernial sac. Objectively a swelling is discovered at the typical place (inguinal region, femoral and umbilical rings); the swelling appears on straining and disappears in a recumbent position and under pressure; moreover, a characteristic

rumbling is noted during reduction of the hernia. The hernial ring can be palpated after reduction of the hernia; through the hernial ring the finger of the examiner pushes the membranes of the sac and the skin inward and penetrates into the abdominal cavity. During the patient's straining and coughing the examiner's finger feels the shock produced by the hernial contents as it enters the hernial sac.

Treatment. The danger of strangulation which is often impossible to prevent necessitates surgical treatment of hernia. Umbi-

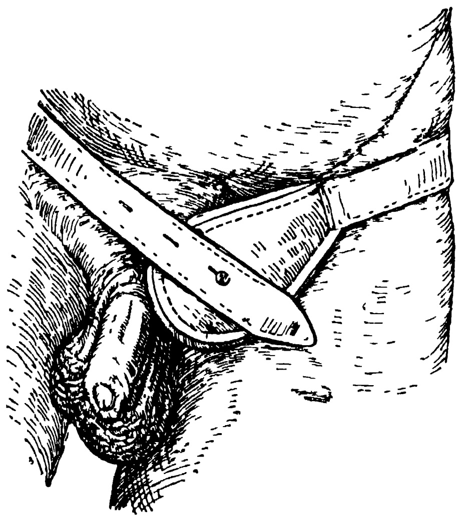


Fig. 253. Binder

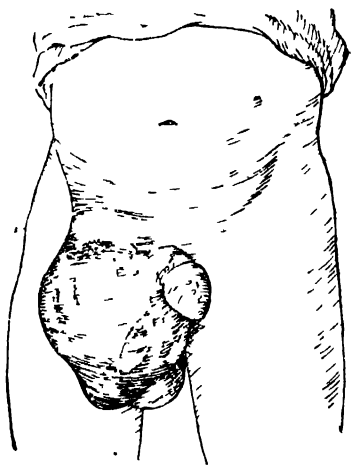


Fig. 254. Inguinal hernia

lical hernia in small children may form an exception. The use of binders (Fig. 253) is indicated only in the few cases in which an operation cannot be performed because of some serious disease or decrepitude of the patient, since a binder does not completely guarantee against strangulation, while long wear of a binder is conducive to enlargement of the hernial ring. In addition to general grave diseases, operations are contraindicated by pulmonary affections, in which cases coughing aggravates the postoperative course of the disease.

Prophylaxis. To prevent development of acquired hernias, it is necessary to select people for hard physical labour (for example, hammerers, loaders, etc.) very carefully. Only persons without defects in the abdominal wall, without expanded inguinal rings and with sufficiently well developed muscles should be allowed to do hard physical work. Transfer of hernia patients from hard physical work helps to prevent strangulation. Lastly, prophylax-

is of hernia includes physical culture which serves to strengthen the musculoaponeurotic apparatus of the abdominal wall.

The muscles and aponeuroses must be strengthened during adolescence by systematic physical culture practised under medical control.

Strangulation of Hernia (hernia incarcerata). On straining, so much of the content (for example, intestinal loops) may enter the hernial sac through the expanded hernial ring that it will be compressed in the hernial gate and will not be able to return to the abdominal cavity. This phenomenon is called elastic *strangulation*. Strangulation may be caused by contraction of the abdominal muscles or the muscles in the region of the hernial ring, a narrowness of the hernial ring and unyieldingness of its edges, adhesions in the sac and intestinal distention.

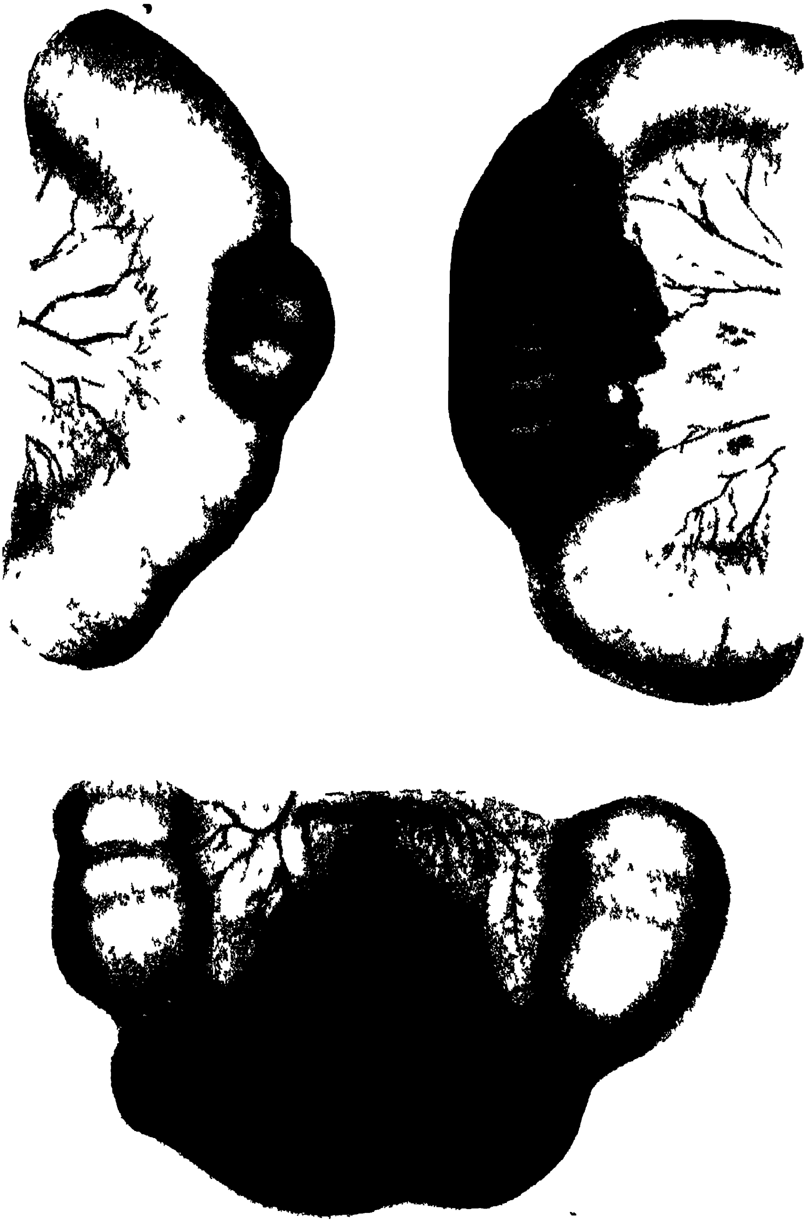
Strangulation because of stagnation of the contents of the intestinal loops located in the hernial sac is called stercoraceous strangulation. Elastic strangulation occurs more frequently. Compression of the omentum and, especially, of an intestinal loop (Table IX), disturbs the outflow of the blood. Edema of the organ which has entered the hernial sac appears first and in graver cases is followed by a disturbance in its nutrition (gangrene, Table IX, 3). The usual result of strangulation is gangrene of the intestine and a stercoraceous fistula, and still more frequently—general peritonitis leading to the patient's death.

In cases of strangulation the patients must be administered urgent aid because *strangulation is dangerous to life*.

The shorter the interval between strangulation and surgical intervention the less danger there is of mortification of the strangulated intestine and general infection of the peritoneum.

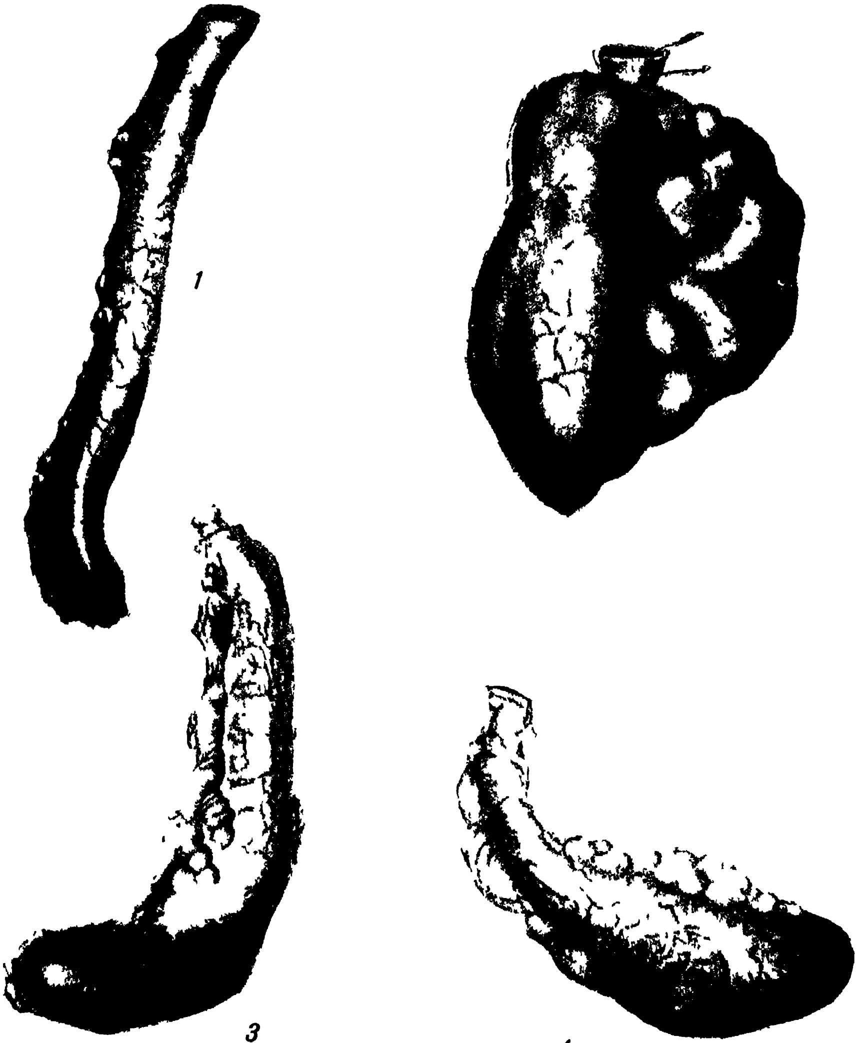
In what cases can strangulation of a hernia be suspected? If the patient has a hernia which can no longer be reduced, and if pains have appeared, the hernia has become tense and painful, the patient vomits and cannot defecate, there is every reason to assume strangulation of the hernia. It is harder to decide the question in cases in which the patient did not know he had a hernia; in such cases, if a swelling suddenly appears in places typical of hernia (inguinal, femoral and umbilical regions), if there are pains, vomiting and retention of the stool, strangulation of hernia should immediately be suspected. As a rule, any strangulated hernia is subject to surgical intervention. Temporary measures favouring reduction of the hernia must be taken before the arrival of a physician or delivery of the patient to a medical institution; these measures include an elevated position of the patient's pelvis and a general warm bath. ***The nurse must under no circumstances try to reduce the hernia.***

Types of Hernias. ***Inguinal hernia*** most frequently occurs in males (Fig. 254). It enters the scrotum through the inguinal ca-



Strangulation of the small intestine in the hernial sac
1—parietal, 2—strangulation of the loop 3—gangrene

TABLE X



Inflammation of the appendix. Phlegmonous appendicitis (*1*), empyema of the appendix (*2*), gangrene (*3*) and perforation of the appendix (*4*)

nal. It may be congenital owing to persistence of the peritoneal protrusion into which the testis descends during the child's development. In women inguinal hernia descends into the major lip.

Femoral hernia (Fig. 255) most frequently occurs in females. It emerges from under the inguinal ligament on to the thigh, medially of the femoral vessels. Femoral hernia is strangulated relatively more frequently and, owing to the density of the ring, gangrene of the strangulated intestine rapidly ensues.

Umbilical hernia (Fig. 256) is most frequently observed in children, elderly women and middle-aged people. In children

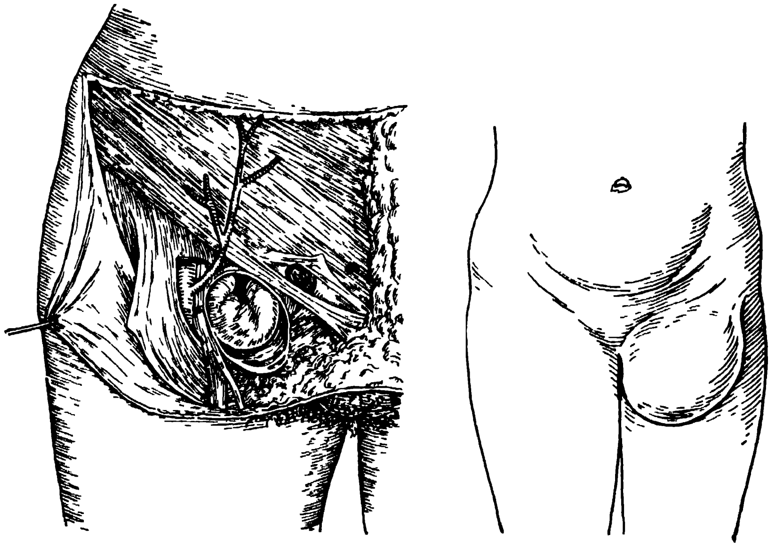


Fig. 255. Femoral hernia

it appears soon after detachment of the umbilicus and is subject to conservative treatment. Appearance of inguinal hernia is fostered by the child's crying, constipation, coughing, tenesmus and poor nutrition. In small children this hernia is successfully treated with plaster bandages; after reduction of the hernia two or three narrow strips crossing over the navel (Fig. 257) or one wider and longer strip are applied; as this is done, the skin over the hernial opening is folded, the hernia is longitudinally covered with a piece of cotton and the abdomen is engirded with a strip of plaster on the level of the navel. At the same time measures are taken to diminish the child's straining (treatment of constipation and coughing). Surgical treatment is indicated only when conservative treatment proves ineffective.

Among adults umbilical hernias most frequently occur and tend to strangulation in elderly corpulent women. The frequently observed plurilocular sac makes possible partial strangulation in a certain part of the sac. Such strangulation is difficult to diagnose. In adults umbilical hernias are subject to surgical treatment.

Hernia of the linea alba not infrequently produces no symptoms and is usually discovered during examination of people engaged in physical labour. Anatomically there is at first no hernial sac in these hernias, but only a protrusion of the preperi-

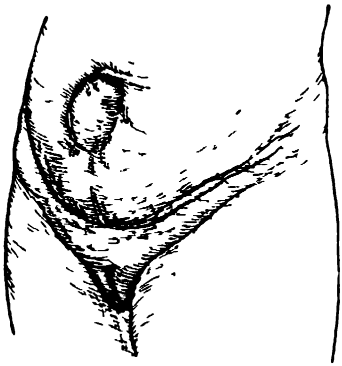


Fig. 256. Umbilical hernia

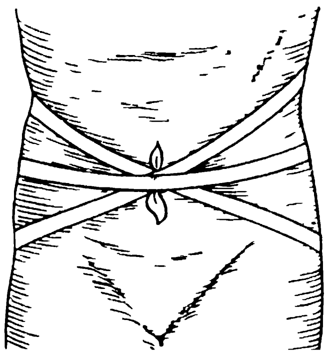


Fig. 257 Application of strips of plaster in umbilical hernia

toneal fatty tissue through the fissures in the aponeurosis of the linea alba. Subsequently a funnel of the peritoneum and a hernial sac are formed, the latter containing mainly the omentum. Hernias of the linea alba never grow to very large size. They are rarely strangulated, but often produce sharp pains, regurgitation, nausea, vomiting and other reflex phenomena of the gastrointestinal tract, which incapacitate the patients for physical labour. These hernias are treated surgically.

Postoperative hernia. If a wound in the abdominal wall heals by second intention, especially if tampons were inserted in the abdominal cavity during its treatment, a weak cicatricial tissue is formed; this tissue subsequently stretches and gives rise to postoperative hernia. Similar hernias may occur in cases of inadequate postoperative sutures. Postoperative hernias tend rapidly to enlarge and may grow to very large sizes, for which reason it is necessary to operate such hernias without delay.

Preparation for the operation. Before the operation it is necessary carefully to prepare the intestines; the patient is kept on a light diet for two days preceding the operation and is given enemas one day before and on the eve of the operation because

the intestinal loops may adhere to the hernial sac. The patient must take a general bath. The operative field and the pubes are shaved.

Patients with strangulated hernias are easier to prepare for the operation. In these cases the bowels are not evacuated, a general bath is given (by prescription of the physician), the operative field and the pubes are shaved.

The operation requires the same set of instruments as is needed for operations on soft tissues. More complex instruments are necessary for operations on postoperative and strangulated hernias, in which the surgeon may discover necrosis of the intestinal loop and may have to resect the intestine. For this reason all the instruments necessary for resection of the intestine must be prepared in addition to the instruments for operating on soft tissues. In most cases herniotomies are performed under local anesthesia, rarely under cerebrospinal anesthesia and only in some cases, i.e., very large and postoperative hernias—under general anesthesia.

Concept of Surgical Treatment of Hernias. The essence of a herniotomy, or radical operation on a hernia consists in isolation of the hernial sac, reduction of its contents, excision of the sac after its ligation at the neck and a plastic repair of the defect in the abdominal wall. In cases of congenital inguinal hernias in children the hernial sac is opened and an internal purse-string suture is applied to diminish trauma to the elements of the cord. The plastic closure of the defect in the abdominal wall is effected variously in the different types of hernia. The methods of Bobrov and Girard-Spasokukotsky are most frequently used in inguinal hernias. With these methods the defect is eliminated by strengthening the anterior or posterior wall of the inguinal canal by suturing the aponeurosis and muscles to Poupart's ligament. A herniotomy requires particularly careful observance of the rules of asepsis because suppuration of the wound leads to a relapse of the hernia.

Postoperative care. The patients are placed in a supine position and are allowed to turn and bend their legs during the very first day. On the second day the patients may be allowed to assume a half-sitting position and, if the disease runs a normal course, they may be allowed to get up on the third or fourth day.

Long confinement to bed especially unfavourably affects aged people who easily develop pulmonary complications, as well as thrombophlebitis and embolisms. The stitches are removed on the 7th or 8th day. The patients are excused from work for 15-20 days and must not lift heavy weights for two months.

On the day following the operation the patients are allowed to take light meals which do not cause intestinal distention (broth, zwieback, porridge, stewed fruit and jellies), may be adminis-

ered enemas, and two days after the operation—laxatives. It is especially important to see that the bowels are evacuated in patients with strangulated hernia, who were operated on urgently, without preparation, if, of course, they did not have necrosis of the intestinal loop and a resection of the intestine was not made. Patients with strangulated hernia are graver cases and require special care, especially those who had gangrene of the intestinal loop and survived a serious operation of intestinal resection. Such patients must be managed like all patients after intestinal and gastric operations.

The grave complications after operations on hernia are pulmonary complications and suppurations of the wound. In cases of a pulmonary process coughing not only causes pain, but also prevents normal healing and is thus conducive to relapses. After herniotomies relapses are observed in a certain percentage of cases, whereas in cases of suppuration or parting of the stitches, which close the hernial ring, relapses of hernia occur without fail.

INJURIES AND DISEASES OF ABDOMINAL ORGANS

Closed injuries. Contusions of the abdominal wall may be accompanied by severe injuries to the internal organs, ruptures of the liver, spleen, stomach, intestines or the mesentery. The main danger of such injuries is shock, internal hemorrhages and infection of the peritoneum with the contents of the gastrointestinal tract.

Patients who are in a state of shock following a contusion to the abdominal region must immediately be put to bed with an ice bag applied to the region of the injury.

Symptoms of injury to internal organs: in ruptures of a hollow organ, i.e., intestine or stomach—persisting tension of the abdominal muscles, sharp pain at the moment of injury and following the injury, and diminished hepatic dullness resulting from the discharge of the gases from the intestines into the free abdominal cavity; in ruptures of the liver or spleen—phenomena of increasing acute anemia, i.e., continuous weakening and acceleration of the pulse, extreme pallor, dryness of the mucous membranes, yawning, blurred vision, thirst, and dull sounds in the lower parts of the abdomen.

In a large majority of cases the injuries to internal organs are cured only surgically. The operation consists in arresting the hemorrhage and suturing the affected organ, and sometimes even in its excision (for example, the spleen). The same instruments are prepared for this operation as for any intestinal operation.

Before the operation the patients must not be given anything to drink because the liquid will gain entrance into the abdominal cavity through the injured stomach or intestine.

During the postoperative period the patients with ruptures of internal organs are considered grave cases and need close watching and thorough care because internal hemorrhages may sometimes recur and there is a danger of a general inflammation of the peritoneum. The patients must be ensured complete rest. During the first day or two ice must be applied to the abdomen as an anti-inflammatory and analgesic agent, if there is any danger of peritonitis. The patients must be administered an abundance of fluids (intravenously and subcutaneously) and antibiotics. In cases of injury to the liver and spleen the fluids may also be ad-

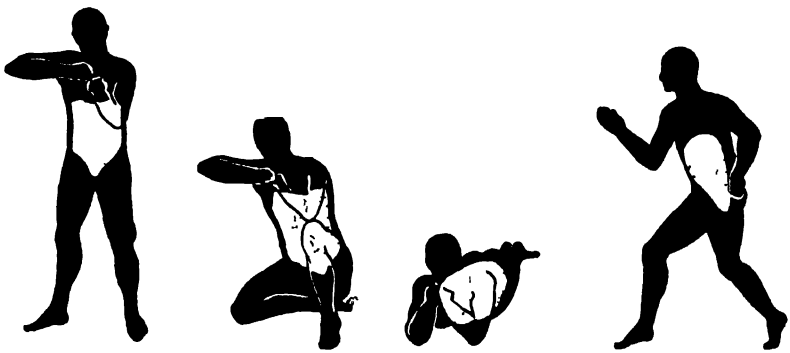


Fig. 258. Silhouettes of the abdominal cavity with a person in different positions

ministered by rectal drip. In instances of acute anemia and generally grave condition repeated blood transfusions are indicated. The patients' diet depends on the nature of injury to the organ and on the operation performed (see below, diet following operations on the intestines).

Injuries to the abdominal cavity. In cases of punctured or gunshot wounds in the abdominal wall it is necessary to determine whether or not the wound penetrates into the abdominal cavity (i.e., whether it is accompanied by injury to the peritoneum) and the direction of the wound canal. This makes it possible to judge whether or not any organs, and precisely what organs, of the abdominal cavity are injured. It is therefore very important to know the position of the patient at the moment the injury was sustained, especially in cases of blind wounds in which the direction of the wound canal is unknown (Fig. 258).

Every wound in the abdominal wall, especially gunshot or punctured wounds, may be accompanied by injury to the abdominal cavity and its organs. If the question is not clear, the wound must be considered penetrating and the physician must not wait for the appearance of symptoms of such injury, because

grave symptoms of injuries to the internal organs not *infrequently* come to the fore only when it is already too late to administer aid.

Owing to the abundance of vessels in the abdominal cavity and the extensively developed vascular network in the parenchymatous organs, injuries to the abdominal cavity are accompanied by hemorrhages, sometimes external, but more frequently into the abdominal cavity. The other important factor in injuries to the abdominal cavity is damage to the abdominal organs (intestines, stomach) which contain an abundance of infective material. Effusion of this material into the abdominal cavity leads to peritonitis sometimes during the very first hours following the injury.

The degree of gastric and intestinal repletion during the injury plays an important part in the subsequent course of the process, because with replete intestines a large amount of their contents will effuse into the abdominal cavity and the danger of peritonitis will increase.

Symptoms. Penetrating wounds of the abdominal cavity yield various symptoms. Some cases present a picture of marked shock and the local symptoms recede into the background. Sometimes the patients feel satisfactory even in severe injuries to the abdominal cavity and are therefore not given adequate attention; such patients may even walk to the first-aid station unaided. A dangerous picture of cavitary injury sometimes develops much later, already during peritonitis.

The signs of hemorrhage into the abdominal cavity are the same as in closed (subcutaneous) injuries and include uneasiness, sometimes unconsciousness, sad countenance, extreme progressive pallor, sometimes cyanosis of the extremities, cold skin and sticky sweat, rapid pulse which becomes thready and in some cases disappears, dyspnea, thirst, etc. Improvement of the patient's condition under the influence of cardiacs is usually followed by a change for the worse and, not infrequently, syncope. Prolapse of the intestines and omentum, and effusion of the intestinal contents into the wound of the abdominal wall are an absolute sign of a penetrating wound. In injuries to the intestine or stomach effusion of their contents into the abdominal cavity, irritation of the peritoneum and phenomena of shock are observed. The patient complains of abdominal pains and his external appearance changes: his features become drawn, his eyes sink and assume a troubled look, the temperature rises, the pulse quickly becomes accelerated, and the tongue is dry and coated. The local phenomena in the abdominal cavity are also characteristic: the abdominal muscles are very tense and very painful to touch; the abdomen subsequently becomes inflated. In addition to these symptoms there are hiccups and vomiting.

Sometimes the picture is not so clear: the patient is indifferent and scarcely complains of pain, the local phenomena—abdominal distention and tension of the abdominal wall—are feebly pronounced, and grave general intoxication comes to the foreground. The patient's external appearance changes, the pulse is altered and cardiac activity rapidly declines.

Treatment. In cases of conservative, nonsurgical treatment of injuries to the abdominal cavity close to 93 per cent of the patients die. Early surgical intervention cuts mortality in half (44 per cent) and even more. The only method of treatment is therefore an earliest possible operation, at any rate before 24 hours have elapsed from the moment of the injury.

First aid consists in transporting the patient as rapidly as possible to where he may be given the necessary surgical treatment. The patient should be transported by the quietest possible means of conveyance on a stretcher and in a recumbent position.

Acute Abdomen. There are several diseases of the abdominal cavity unified under the common designation of acute abdomen. If prompt surgical treatment is not administered, these diseases usually lead to general acute inflammation of the peritoneum and the patient's death. They are unified in a single group mainly because they require urgent surgical intervention sometimes without a precise diagnosis, on mere suspicion of one of the diseases of this group. The picture of acute abdomen is determined by the following signs which occur in aggregate, as well as separately: 1) sharp, ceaseless abdominal pain, 2) continuous nausea and vomiting, 3) protracted retention of the stool, and 4) extremely distended or very tense abdomen.

The diseases which produce such a picture include *perforation* of some abdominal organ with effusion of its contents into the abdominal cavity (perforation of gastric ulcer, perforation of the appendix, perforation of the gallbladder). In cases of perforation of an abdominal organ a picture of peritoneal shock is observed, namely, a pale, frightened face with an expression of suffering, excited or depressed state, cold sweat, shallow and rapid costal breathing, small pulse and local abdominal phenomena—pain all over the abdomen, particularly sharp in the region of the perforated organ, extreme tension of all the abdominal muscles, and sometimes diminution and disappearance of hepatic dullness.

Acute abdomen includes intestinal obstruction. Sharp, unceasing paroxyzmal pains, extreme abdominal distention (at first the abdomen is not tense), protracted retention of the stool and, frequently, continuous vomiting are observed in this disease. Acute abdomen also includes acute appendicitis, acute pancreatitis, extrauterine pregnancy, acute pelvic peritonitis in women, and several other affections.

Preparation for the operation consists in shaving the operative field. In most cases the patients are not given a bath and their bowels are not evacuated. If the patient is in a grave general condition, he is administered physiologic saline solution or glucose before the operation. The same instruments as for laparotomies with intervention in the gastrointestinal tract are prepared for the operation.

Postoperative care depends on the disease and the operation performed, and will be discussed in the corresponding chapter.

Peritonitis. The serous membrane lining the abdominal wall (parietal peritoneum) and enveloping the intestines and other organs of the abdominal cavity (visceral peritoneum) forms a large cavity with many folds. Normally, the peritoneum secretes a small amount of serous fluid and easily absorbs the liquids which have gained entrance into it. Infection may penetrate into the peritoneum from diseased adjacent organs, through intestinal walls (if their viability is disturbed), during injuries (from the outside) or from the intestines and with the blood stream.

In all cases of peritonitis it is very important to establish whether the process involves a limited part of the abdominal cavity (localised or circumscribed peritonitis) or is unlimited and has spread over the entire peritoneum (generalised or diffuse peritonitis). In discussing peritonitis we shall imply mainly the latter disease.

Serous, purulent and putrefactive forms of peritonitis are distinguished according to the character of the exudate. As was already mentioned, infection gains entrance into the abdominal cavity through various channels; in accordance with this the following types of peritonitis are distinguished: peritonitis associated with appendicitis (appendicular peritonitis), peritonitis in females associated with diseases of the sexual organs (following abortion or parturition, and in purulent inflammation of the fallopian tubes), peritonitis connected with perforated gastric ulcers, strangulations and ileus, peritonitis caused by injuries to the abdominal cavity and, lastly, postoperative peritonitis.

Etiology. The most frequent *causative agents* of peritonitis are streptococci, staphylococci, colon bacilli, pneumococci and gonococci. Not infrequently, especially in cases of perforated peritonitis, various bacteria, including anaerobes and colon bacilli, penetrate into the abdominal cavity and cause the disease (mixed infection).

Owing to the formation of a fibrinous and cellular exudate, the abdominal organs adhere to each other, isolating and demarcating the focus of infection. In these cases the omentum plays a very important part. Subsequently the fibrinous adhesions are organised and replaced with dense connective-tissue adhesions between the organs of the abdominal cavity (plastic peritonitis).

The initial *symptoms* of peritonitis are: pains in the abdominal cavity and diffuse muscular tension of the abdominal wall; retracted and tense abdomen ("abdomen like a board"), altered type of respiration, disappearance of abdominal respiration, appearance of shallow costal respiration, sharp pain on touching the abdominal wall. Moreover, the patient feels a sharp pain not so much at the time pressure is applied to the abdominal wall as at the moment when the hand is quickly removed (Shchotkin-Blumberg sign). The peristalsis, especially of the small intestine, ceases soon after the onset of peritonitis, the discharge of gases is disturbed owing to intestinal paresis and the abdomen becomes distended.

The first general symptoms of peritonitis not infrequently include hiccups, vomiting and, sometimes, regurgitation of small amounts of food. In some cases of peritonitis the temperature is high and in some it drops. At the same time the pulse is considerably accelerated. This discrepancy between the pulse rate and the temperature is considered a characteristic sign of peritonitis. In this disease the patient's external appearance rapidly changes, namely, the patient develops pallor, breaks out in cold sweat, the facial features become drawn (facies abdominalis), dark rings appear under the sunken eyes, and the tongue is coated and dry. The patient may be excited, but is most frequently depressed; sometimes the patient's consciousness is clouded, especially during the last stages. The blood shows leukocytosis and a shift of the formula to the left (increase in neutrophils and young forms). The amount of urine decreases, and protein and casts appear in it (toxic affection of the kidneys). In grave cases of peritonitis the patient dies within a few days. In neglected cases the diagnosis of peritonitis is clear, but in the beginning of the affection, when it is particularly important, the disease is sometimes very difficult to diagnose.

Treatment. Peritonitis is a very grave disease. The best results are produced by surgical treatment during the initial period, when the disease has not as yet caused severe general intoxication. Peritonitis patients are usually operated on urgently, so that the intestines cannot be prepared and the patients cannot be given a bath; it is necessary only to shave the abdominal wall and the region of the pubes.

The same set of instruments is prepared for this operation as is for laparotomies with intervention in the gastrointestinal tract.

Modern treatment of peritonitis is successful because of the timeliness of surgical intervention (in the beginning of the disease) and the most rapid elimination of the source of the disease (for example, the appendix), suturing or excision of the perforated or wounded organ. If the source has been eliminated, the abdominal cavity is cleaned with gauze compresses, avoiding trauma

to the peritoneum, or the pus is aspirated, and the abdominal cavity is closed up, or else a thin drain is left for subsequent administration of antibiotics.

In cases of a limited process (abscess) which has produced encapsulation, or if the causes of infection in the abdominal cavity have not been eliminated, the draining is effected by insertion of drainage tubes or gauze drains in the abdominal cavity. However, owing to the complex topography of the abdominal cavity and the ability of the peritoneum to circumscribe the process, the inserted drains and tampons are soon demarcated from the rest of the abdominal cavity.

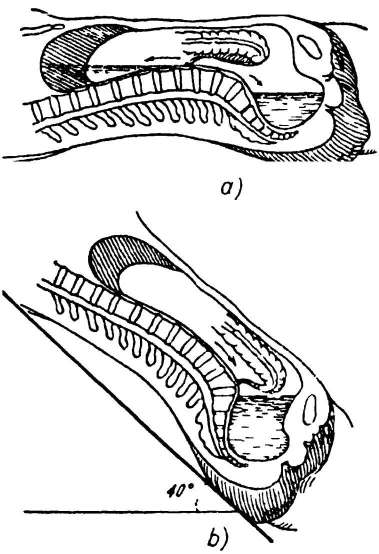


Fig. 259. *a*—accumulation of exudate in the subdiaphragmatic space with the patient in a supine position; *b*—accumulation of exudate in the region of the minor pelvis with the patient in a half-sitting position

In some cases, after suturing the peritoneum, the abdominal wall (muscles and skin) are left unsutured to avoid a purulent process in the subcutaneous tissue infected with the pus from the abdominal cavity.

Prophylaxis. In most cases proper and timely treatment of the diseases which are complicated by peritonitis will prevent peritonitis. In injuries to the abdominal cavity this will be early surgical treatment; in perforations, for example, of gastric ulcer, it will be surgical elimination of the perforation; in inflammatory processes, for example, in appendicitis, it will be a timely surgical excision of the affected appendix, etc. Thus, timely diagnosis and proper treatment of diseases of abdominal organs may, in a great majority of cases, prevent development of peritonitis.

Care. Postoperative care is a very important matter, especially during the first days of the disease. The patient is placed in a half-sitting position to improve the descent of the fluid from the upper parts of the abdominal cavity (Fig. 259). To diminish intoxication, large amounts of fluid are administered mainly intravenously, subcutaneously or by the drip method. Up to three litres of physiologic saline solution with 500-600 ml of a 5 per cent glucose solution and insulin are administered per day.

Simultaneously large doses of cardiacs (camphor in doses of 5-10 ml 3-4 times per day, caffeine, digalen, etc.) are vigorously administered. In peritonitis good results are produced by blood transfusion during the postoperative period (especially by the drip method). It is necessary carefully to watch the pulse and temperature. Peritonitis patients must not be fed during the first days after the operation, but must be given parenteral nourishment by administration of proteins and glucose.

It is necessary to observe oral hygiene. The patients are given to drink in small amounts and only if they do not vomit. In cases of excruciating vomiting and considerable abdominal distention the stomach is emptied, a permanent thin gastric tube with continuous suction is introduced into it and a colonic tube is inserted in the rectum. Serious attention must be devoted to the respiratory organs because of the possibility of pneumonia; for the purpose of prophylaxis mustard plasters are applied to the chest and back, the patients are given to inhale carbon dioxide several times a day, etc.; on the second or third day the patients begin to perform breathing exercises.

If the abdominal cavity is being drained, the dressings may be very painful to the patient, for which reason, while the upper layers are being changed, attempts are made to loosen the tampons by pulling on their central parts. When the tampons have to be changed (most frequently on the 6th day after the operation) morphine is injected before the dressing because the latter is very painful. Subsequently such patients begin to be fed very carefully and only after improvement of the local phenomena (discharge of gases, diminution of pains and of the tension of the abdominal wall). The bowels are evacuated by enemas and no laxatives are administered until the process has abated. The urine is usually collected for the purpose of measuring its quantity. In peritonitis complications not infrequently involve the lungs and include residual abscesses in the abdominal cavity, under the diaphragm and in the liver, parotitis and general sepsis; these complications may require repeated surgical intervention.

Diplococcal peritonitis. Children's diplococcal peritonitis constitutes a peculiar form of the disease. It is observed in girls 2-12 years of age. The tonsils in angina or the mucosa of the sexual organs during their diplococcal infection serve as the infection atrium. The disease begins with intense pains in the abdominal cavity, vomiting and diarrhea. The temperature rises to 40°C, the general condition is grave, the consciousness is clouded and the pulse is rapid. Leukocytosis—up to 30,000-40,000. The abdominal muscles are less tense and painful than in other forms of peritonitis. Since surgical treatment of this form of peritonitis produces poor results, it is advisable to wait until the process has become demarcated and pus has accumulated. At the same

time general measures are taken, namely, infusion of physiologic saline solution, administration of cardiacs, streptocid per os, antibiotics, and local application of cold or heat, depending on the circumstances, to the abdomen.

Appendicitis. Inflammation of the vermiform appendix of the cecum is called appendicitis and is one of the most frequent diseases of the abdominal cavity. Appendicitis patients constitute a considerable percentage of all surgical patients.

Clinically, appendicitis is divided into acute and chronic forms, according to its course and the pathoanatomical changes in the region of the appendix.

Acute appendicitis. The causative agents of acute appendicitis are most frequently streptococci (enterococci), staphylococci, colon bacilli, diplococci and various anaerobes.

The cause of the development of the inflammation in the appendix is not completely clear as yet.

The aforesaid microbes may be found in the intestines and the appendix without producing an inflammatory process.

They may gain entrance into the appendix with the blood stream (hematogenically) or, which is apparently more frequently the case, from the intestines (enterogenically), the development of appendicitis possibly being conditioned by a change in the virulence of the microbes. Nor can we exclude the role of dietary disorders which cause stagnation of the contents of the appendix, chronic constipation, intestinal sluggishness and chronic diseases of the large intestine.

The *pathoanatomical* changes in appendicitis consist in swelling of the follicles, serous and then purulent inflammation which begins with the follicular tissue of the appendix and ends in purulent impregnation of all layers of its wall. The subsequent development of the process not infrequently gives rise to thrombosis of the vessels and, owing to this, necrosis of a part of the wall or the entire appendix (gangrene); in partial necrosis perforation occurs and is accompanied by effusion of the contents into the abdominal cavity (Table X).

During the inflammatory process in the appendix a serous and serofibrinous exudate appears in the abdominal cavity near the appendix. If the infection penetrates through the walls of the appendix, the exudate becomes turbid and then purulent. During precipitation of the fibrin the fibrinous exudate causes adhesion of the intestinal loops to each other, to the abdominal wall and the omentum, which favours demarcation of the process.

In a demarcated inflammatory process a dense inflammatory swelling (infiltrate) appears on the second or third day after the onset of the disease (Fig. 260). But, if the process develops rapidly and is insufficiently demarcated from the free abdominal cavity, it involves the peritoneum and causes generalised peritonitis. This

most dangerous complication is observed particularly frequently in perforated and gangrenous appendicitis. The inflammatory infiltrate may gradually be resorbed in the course of a few weeks, or dissolution of the tissues occurs in its depth and pus accumulates, i.e., an appendicular abscess is formed. The latter may open through the abdominal wall or, what happens more frequently, into the intestines or into the free abdominal cavity, which may cause generalised peritonitis.

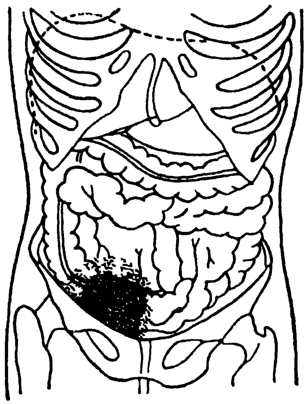


Fig. 260. Appendicular infiltrate

Symptoms. Acute appendicitis most frequently begins suddenly, while the patient is completely healthy (attack of acute appendicitis), with appearance of pain in the right iliac region and sometimes all over the abdomen or in the epigastrium with subsequent concentration of pain in the right iliac region.

Soon nausea appears and the patient begins to vomit, the temperature rises sometimes to 38-39°C, but in the beginning it is usually not high—slightly above 37°C. The intestines either fail to function or function normally, although diarrheas are sometimes observed. Examination of the patient usually reveals pain and limited muscular tension in the right iliac region. The blood shows leukocytosis and changes in the leukocytic formula characteristic of an inflammatory process (shift to the left with appearance of young forms of neutrophils).

In most cases appendicitis is not difficult to diagnose, but sometimes the picture may be unclear in the beginning of the disease and may resemble an acute intestinal process (enterocolitis), dextral renal colic, etc. It is particularly easy to overlook acute appendicitis in children in whom it runs a violent course and often soon produces general phenomena with negligible local phenomena (children cannot very well point out the location of pain and not infrequently complain of pain in the epigastrium or all over the abdomen).

Appendicitis may run various courses. In mild cases all phenomena abate within 3-4 hours. A severer attack of perforating appendicitis begins like that of acute appendicitis; however, this leads to gangrene or perforation of the appendix with effusion of the contents into the abdominal cavity and generalised peritonitis.

But even the milder cases of appendicitis far from always end favourably. In many cases an inflammatory swelling (infiltrate) forms in the region of the appendix on the second or third day,

this swelling being palpable through the abdominal wall. Pus may form in the centre of the infiltrate, i.e., it may give rise to an appendical abscess which constitutes circumscribed purulent peritonitis. In such cases the temperature either remains high or drops in the morning and rises in the evening. Palpation of the centre of the infiltrate may reveal a softening. If an abscess has formed, it must be opened surgically and drained. However, under the influence of treatment the infiltrate is most frequently resorbed without forming pus.

Appendicitis is considered *chronic* when pains persist in the region of the appendix after the end of the attack and also when the attacks follow each other, even if at long intervals of several years (relapsing chronic appendicitis).

In rarer cases appendicitis runs a silent course. Lastly, there are cases of primary-chronic appendicitis without the characteristic acute attacks. The etiology of the chronic process is the same as that of the acute process. The pathoanatomical picture of chronic appendicitis consists mainly in sclerotic changes in the walls of the appendix with replacement of the muscular and other layers of the appendical wall by dense, vessel-poor connective scar tissue. Adhesions with the abdominal organs surrounding the appendix (omentum, intestinal loops) are noted. Owing to formation of scar tissue in the wall and the adhesions, the lumen of the appendix is not infrequently constricted and forms kinks. In chronic appendicitis the aforesaid changes in the appendix may favour aggravations and in cases of the latter the cicatricial tissues of the appendicular wall which have low resistance with respect to the infection are easily necrotised and dissolved, producing perforated or gangrenous appendicitis.

Symptoms. Usually the symptoms of chronic appendicitis are not strongly pronounced. The presence of at least one authentic attack of appendicitis in the anamnesis is very important.

The patient most frequently complains of pain in the right iliac region, the pain increasing after coarse food and sometimes during locomotion, dyspeptic phenomena and constipation. Examination of the abdominal region reveals pain at the point which is midway between the navel and right anterior superior iliac spine and on the border between the right and middle third of the line connecting both iliac spines.

Prophylaxis. It is difficult to prevent appendicitis and recurring aggravations because of the vagueness of the etiology. Proper regular nutrition with food rich in vegetable cellulose and prevention of constipation are apparently of some importance.

Treatment. In the beginning of the disease it is not always possible to determine whether the patient has a mild attack of appendicitis, or it is the beginning of perforated or gangrenous appendicitis. Acute appendicitis therefore necessitates urgent

surgical intervention, preferably during the very first hours of the disease, as soon as the case has been diagnosed. Only if there is an infiltrate in the region of the appendix must the surgeon wait for the infiltrate to be resorbed, the inflammatory process to abate or an abscess to form.

In cases of an infiltrate the patients are usually treated as follows: they are confined to bed and are not allowed to move except turning to the affected side, bending their legs in the knees and assuming a half-sitting position with the aid of some support. No laxatives are administered because contraction of the intestines under the influence of laxatives may break the adhesions and favour extension of the process. During the acute period, before the temperature drops, an ice bag is placed on the right iliac region and the patient is kept, if possible, on a restricted diet. Penicillin and other antibiotics are the medicinal agents administered. As soon as the acute phenomena subside and the temperature drops, compresses and hot water bottles are applied to accelerate resorption.

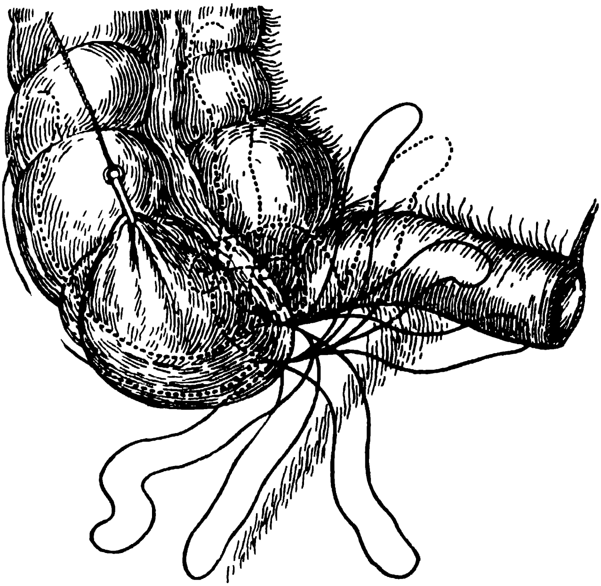


Fig. 261. Various positions of the appendix

The patients must not be given narcotics which, although eliminating pain, obscure the picture of the disease. The best prevention of complications during acute appendicitis is an urgent operation.

The operation consists in opening the abdominal cavity with an oblique incision in the right iliac region or in an incision along the edge of the right rectus abdominis muscle.

For local anesthesia 200-500 ml of a 0.5-0.25 per cent novocain solution, syringes, and needles are prepared.

If an oblique incision has been made, after dissection of the skin and subcutaneous tissue the hemorrhage is arrested with the aid of Kocher's and Péan's hemostatic forceps, the aponeurosis is opened, the fibres of the muscle are parted lengthwise with Kocher's probe and Cooper's scissors.

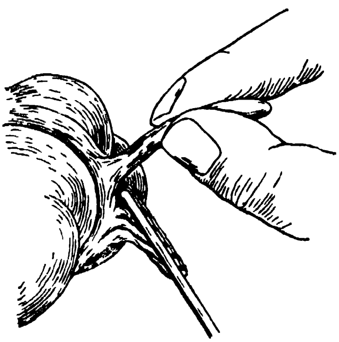


Fig. 262. Transection of the appendicular mesentery

Retractors serve to part the muscles (see Fig. 44).

After opening the peritoneum, the cecum and the appendix are searched for, since the position of the latter greatly varies (Fig. 261).

After drawing out the appendix, a hemostatic clamp is placed on the mesentery, the latter is incised (Fig. 262) and ligated. A purse-string suture is applied around the base of the appendix (Fig. 263). Payr's clamp is placed on the appendix at its base and the base is ligated.

After resection of the appendix its stump is painted with iodine tincture, invaginated (Fig. 264, *a*) and the purse-string suture is tightened (Fig. 264, *b*). After setting aside all the instruments that may have become infected during resection of the appendix, a second suture is applied above the purse-string suture and all the layers of the abdominal wall are sutured (catgut is used for suturing the peritoneum and muscles, and silk—for suturing the aponeurosis and the skin).

Since chronic appendicitis may, when aggravated, run a course resembling gangrenous or perforated appendicitis, it is necessary to resort to surgical treatment also in this form of the disease.

Cases of chronic appendicitis are operated preferably during intervals between the attacks, during so-called cold periods. An operation on chronic appendicitis is therefore a form of prophylaxis which prevents an acute attack with all its dangers, especially since perforation and generalised inflammation of the peritoneum may occur during any of the subsequent attacks. One or several acute attacks of appendicitis, if established authentically, serve as an indication for surgical intervention.

Preparation for the operation. Preparation for operations on acute appendicitis is simple in all cases, because the operation

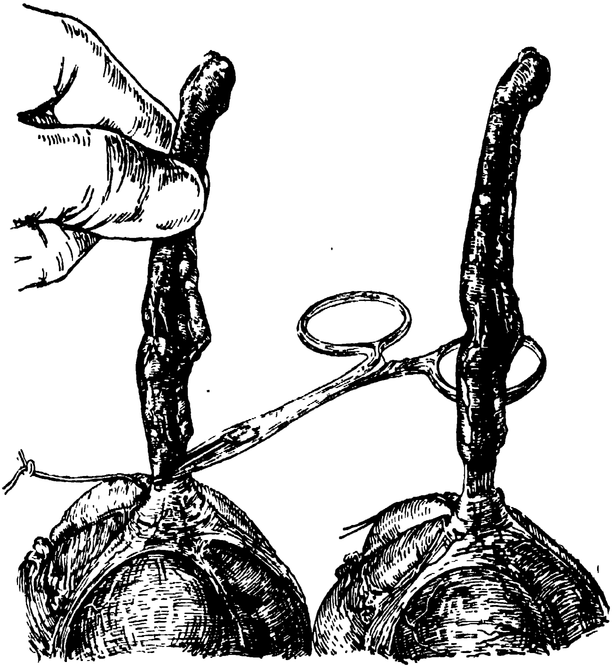
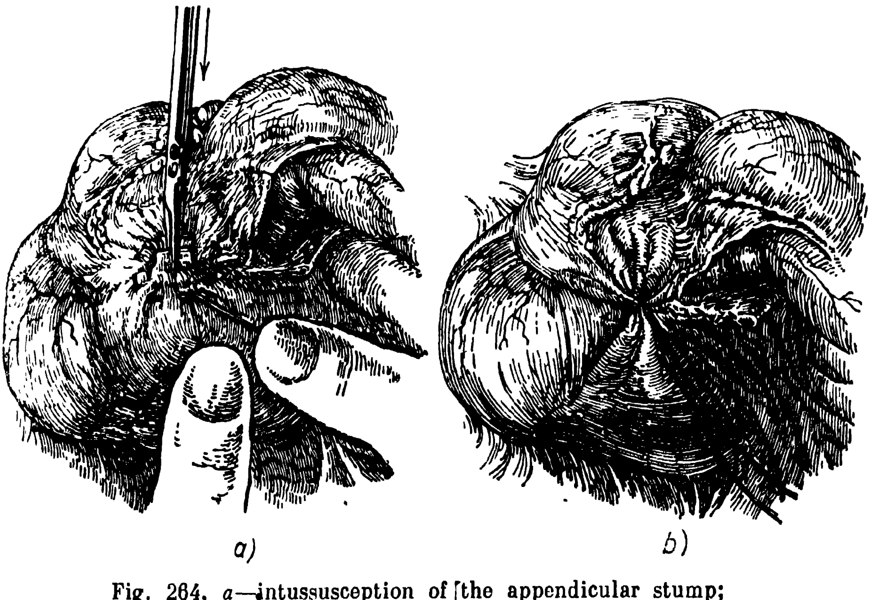


Fig. 263. Application of a purse-string suture, crushing and ligation of the appendix



a)

b)

Fig. 264. *a*—intussusception of the appendicular stump; *b*—tightening the purse-string suture

is performed urgently. The patients are not given a bath, with perhaps the exception of mild cases.

No laxatives must be administered; as a rule, no enemas are given either. It is only necessary to shave the region of the operation and the pubes, and to give the patient no food or drink before the operation.

In chronic appendicitis the patient is prepared for the operation as for an ordinary operation, if there is no aggravation, fever, vomiting or pains.

After the operation an ice bag or a weight (a sandbag) is placed on the region of the wound. The personnel must see to it that the ice bag does not leak and does not moisten the dressing, and that no sand comes out of the sandbag.

Care. The care of an appendicitis patient must be individual, depending on the form of the disease with which the patient is affected. Patients with perforated and purulent appendicitis are at first managed like patients with peritonitis. During the first days they receive neither food nor drink (they are administered glucose and physiologic saline solution subcutaneously) and are kept in a supine position. Subsequently the care of the patients depends on the development of the disease. If tampons are inserted in the abdominal cavity, the care is more stringent during the postoperative period, i.e., the patient remains in a recumbent position and is given only liquid food for five or six days. If the disease takes a favourable course, the patient receives liquid, gruelly food (porridge, jellies and soups) on the second or third day and then white bread; on the 4th or 5th day the patient is transferred to a light diet. If the temperature is normal, the patient is allowed to sit up on the second or third day and to walk on the 4th or 5th day. Some surgeons allow their patients to get up early, even on the day following the operation. During postoperative management special attention is devoted not only to the patient's temperature, pulse, the state of the dressing, etc., but also to the condition of the tongue (dry, moist, coated), pain in the abdomen, abdominal distention and discharge of gases; the patient must also be watched as regards urination.

Several complications are possible in grave acute and, especially, in purulent or perforated, appendicitis. These include abscesses in the abdominal cavity and subdiaphragmatic abscesses, general purulent infection (septicemia) and pulmonary complications. Lastly, appendectomies are sometimes followed by paralysis of the intestines with sharp meteorism. This flatulence is not dangerous, although it is quite unpleasant to the patient. In such cases, in addition to medicinal agents (atropine), a colonic tube and syphon enemas, as well as enemas of 1.5-2 glassfuls of a 10 per cent hypertonic common salt solution are used. The

enemas are administered carefully, beginning on the second day after the operation.

Suppuration of the postoperative wound is a frequent complication of appendicitis, especially acute appendicitis. The infection may gain entrance into the region of the surgical wound from without during the operation, but most frequently penetrates into it from within, from the focus of the inflammatory process, i.e., from the appendix. The infection with which the peritoneum can easily cope produces a purulent process in the subcutaneous tissue. During the postoperative period suppuration of the wound is manifested in pyrexia, pains, swelling and presence of an infiltrate in the region of the surgical wound. If suppuration develops in the wound, the stitches must be removed and the wound opened as soon as possible.

Operations performed during the cold period of chronic appendicitis, like the operations carried out during the first day of acute appendicitis, offer a very favourable prognosis with low mortality and few complications.

Hence, the importance of timely diagnosis of acute appendicitis and of early operation, i.e., on the first day of the disease, is self-evident.

Tuberculous Peritonitis. Tuberculous affection of the peritoneum (tuberculous peritonitis) is most frequently observed in its chronic form. It may be either generalised or affecting only some parts of the abdominal cavity. The disease is usually manifested in moderate pains, abdominal distention, sometimes vomiting, tension of the abdominal wall and pyrexia; fluid accumulates in the abdominal cavity. Extreme loss of weight and general emaciation are noted and in the end lead to death. The disease runs a long course—several months and longer.

In tuberculous peritonitis general treatment of tuberculosis is administered; irradiation of the abdomen with a quartz lamp and painting of the skin with iodine tincture are local measures; surgical treatment consists in opening the abdominal cavity and removing the fluid. Following this the abdominal wall is closed tight. Such an operation sometimes considerably relieves the patient.

Ascites. In a number of diseases of the liver and disorders of the cardiac function, as well as in malignant tumours of abdominal organs, an enormous amount of fluid (ascites) accumulates in the peritoneum, renders respiration difficult and afflicts the patient with pain.

To alleviate the suffering in ascites, a palliative intervention is effected, i.e., draining the ascitic fluid by means of an abdominal puncture. The puncture can also be of diagnostic value in elucidating the character of the fluid. To produce the puncture, it is necessary to sterilise the syringe and

needle, a trocar, a long director or bulbous-end probe, a needle on a needle holder and ligatures for the suture, and a 0.5 per cent novocain solution. The skin in the region of the puncture is painted with iodine. The puncture is made with the trocar along the midline below the navel or between the navel and the pelvic bone, the point of puncture being anesthetised beforehand. An abdominal puncture is best made with the patient in a sitting position (on the edge of the operating table or on a chair). The abdomen is tied with a towel above the point of the puncture and is continuously compressed in an attempt thereby to maintain the intrathoracic pressure since the latter drops as the ascitic fluid is drained. As soon as the fluid is drained, the patient is placed on his back, the wound is covered with a collodion dressing and the abdomen is tightened with a bandage.

While the fluid is being drained, it is necessary to watch the pulse because of the possibility of a sudden decline of cardiac activity, which requires a subcutaneous injection of cardiacs (caffeine). If the dressing is soaked in the ascitic fluid, it must be changed.

Diagnostic Laparotomy. In a number of diseases of the abdominal organs requiring urgent intervention (acute abdomen) a more accurate diagnosis can be made only during the operation. In some tumours of the abdominal organs, in the beginning of their development (cancer of the stomach), and in injuries the diagnosis is similarly rendered more precise only during the operation. The operation performed for the purpose of ascertaining the diagnosis is called a diagnostic (exploratory) laparotomy. The same instruments are prepared for this operation as for an intestinal operation.

INJURIES AND DISEASES OF THE STOMACH AND GASTROINTESTINAL TRACT

Surgical interventions are effected for injuries, burns, foreign bodies, gastric ulcers, cancer of the stomach, constriction of the pylorus, etc.

Injuries to the Stomach. These are often encountered in injuries to the abdominal cavity accompanied by injuries to other organs (intestines, liver). In injuries to the stomach a very important part is played by injuries to its vessels accompanied by hemorrhages into the abdominal cavity. Moreover, the contents of the stomach also effuse into the abdominal cavity and cause peritonitis. All that was said about penetrating abdominal wounds fully pertains to injuries to the stomach.

The most characteristic features of injuries to the stomach are vomiting of blood (in one-third of the cases), diffuse tension of the anterior abdominal muscles, a picture of shock immediately or dur-

ing the first hours following the injury, and disappearance of hepatic dullness due to discharge of the air from the stomach. Whether the stomach was empty or filled with food at the moment the injury was sustained is of essential importance. Injury to an empty stomach, of course, offers a better prognosis and, contrariwise, injury to the stomach replete with food—the worst prognosis. The only method of treatment is an earliest possible operation which consists in suturing the wound of the stomach. The patient must under no circumstances be given anything to drink either before or after the operation. The postoperative feeding of the patient is the same as it is after other operations on the stomach.

Fig. 265. Penetrating gastric ulcer

Gastric and Duodenal Ulcers (ulcera ventriculi et duodeni) (Fig. 265). Gastric and duodenal ulcers constitute one of the most frequent diseases subject to surgical treatment.

The *etiology* of this disease is as yet insufficiently clear. An important part in this disease is apparently played by a number of neurotrophic factors in virtue of which the erosion formed does not heal but deepens, and a typical ulcer with a deep craterlike floor and indurated callous (cicatricial) edges is formed.

The spasm of the muscles and blood vessels caused by disturbances in the function of the nervous system is also very important. General trophic disorders result in lowered resistance and digestion of the mucosa by the gastric juice. Subsequently, the mechanism of the development of the ulcer is determined by the unceasing action of the former factors and pathological impulses of a nature of a conditioned reflex from the affected organ (K. Bykov's corticovisceral theory).

Pathologic anatomy. Ulcers are most frequently located along the lesser curvature of the stomach in the pyloric region and in the duodenum. They tend to deepen and may perforate the gastric wall, in which case the contents effuse into the free abdominal cavity (perforation), or the ulcer extends to an adjacent organ if the latter adheres to the stomach (for example, the liver, pancreas). This extension of the ulcer into the adjacent organ is called penetration. During penetration an ulcer may cause an inflammatory process in the neighbourhood and adhesion to the adjacent organs (liver, pancreas). Erosion of vascular walls, causing gastric hemorrhage, is not infrequently observed.

If an ulcer heals by cicatrisation, it may subsequently lead to constriction of the pyloric orifice (pyloric stenosis). Ulcers existing for a long time predispose to cancer.

The *symptoms* of ulcers are dealt with in greater detail in courses of internal diseases. The main symptoms are pain, vomiting after meals, and blood in the vomit or the excrements.

Constant heartburn and pains, especially in the epigastrium, soon or 3-4 hours after meals are characteristic of gastric ulcers. Pains on an empty stomach, hunger pains which abate after meals, and night pains are most frequently observed in duodenal ulcers. In chronic cases the pains sometimes diminish for a certain period (several months or even years), but then recur and become increasingly more intense (cyclic recurrence of the disease). The pains differ in character and are sometimes so intense that the patient does not know what to do; most frequently he doubles up and presses his legs to the abdomen to relax the abdominal wall. The pains abate after the patient has taken sodium bicarbonate. Gradually, in the course of the disease, the pains grow more intense.

Vomiting is a very frequent symptom of ulcer. In most cases it occurs within a certain period, namely, from 30 minutes to three hours after meals, at the height of the pains; after vomiting the pains usually subside or cease altogether.

The vomit may contain blood. Sometimes profuse hemorrhages are observed. During profuse hemorrhages the blood is bright red, but under the action of gastric juice in the vomit it most frequently resembles coffee grounds. In some cases, especially during hemorrhages from a duodenal ulcer, the blood is not ejected with the vomit, but is discharged into the intestines; such cases of concealed hemorrhages are manifested by symptoms of acute anemia (vertigo, weakness, nausea, extreme pallor, rapid and weak pulse). After a certain period of time—from three or four hours to several days—the blood is excreted with the feces. Hemorrhages are usually detected by the colour of the feces which look like tar. The dark colour of the feces is not always due to the presence of blood; the feces sometimes assume this colour when a person has eaten whortleberries or has taken powders of bismuth and iron. In some cases a hemorrhage may be detected only by examination of the feces. The other dyspeptic phenomena in gastric ulcer include heartburn, regurgitation and nausea. It is very important to analyse the gastric juice; usually the analysis shows it to be highly acid: general acidity—above 70, fixed hydrochloric acid—above 50 and free hydrochloric acid—40.

The following changes discovered by roentgen examination are characteristic of gastric ulcers: serration of the greater curvature and protrusion of the contours of the gastric wall (niche).

If evacuation of the stomach during constriction of the pylorus is difficult, the stomach should be irrigated before the examination.

A roentgen examination of a patient with a gastric disease is performed as follows: the patient is given a jelly or thin gruel consisting of cooked starch and 50-100 g of barium sulfate. Since barium salts are impermeable to roentgen rays, the barium filling the stomach forms a shadow on the screen. By this shadow it is possible to determine the shape, position and movements (peristalsis) of the stomach, its evacuation, etc. In cases of tumours the corresponding part of the stomach is not filled with

Fig. 266. Niche. Roentgen picture of the stomach

the barium mass, and the screen shows what is called a *defect* of repletion. Contrariwise, in the presence of an ulcer, especially if it extends deeply beyond the limits of the stomach, the barium mass penetrates beyond the contours of the stomach forming in this place a projection, pocket (niche) (Fig. 266).

The symptoms of gastric ulcer are not always sufficiently typical. In some cases only one of the three basic signs is clearly pronounced. There are also cases in which gastric ulcer produces no symptoms at all and perforation of the ulcer or a profuse hemorrhage constitute the first sign.

The *treatment* of gastric ulcer patients is conservative (diet, belladonna, sodium bicarbonate, etc.).

Perforated gastric ulcers are subject to urgent and unconditional surgical intervention as some of the gravest diseases of the

abdominal cavity, since in these cases the gastric contents gain entrance into the abdominal cavity and cause fatal generalised peritonitis. In these cases it is particularly important to effect rapid surgical intervention immediately after the perforation of the ulcer.

Stenosis of the pylorus after healing of gastric ulcers with cicatrisation also serves as an indication for surgical treatment.

In all other cases an operation is indicated when the affection stubbornly resists conservative treatment, there are frequent hemorrhages which weaken the patient, and the patient has callous or penetrating ulcers.

Complications. Perforation of an ulcer and hemorrhages require urgent measures. The basic symptom of *perforation* is a sudden appearance of cutting pain in the epigastrium resembling a stab with a dagger. Examination of the patient reveals great tension of the abdominal muscles, especially in the upper part of the abdomen, with a simultaneous retraction of the abdominal wall (navicular abdomen). Abdominal (diaphragmatic) respiration is replaced with costal respiration, the hepatic dullness disappears and tympanitis appears above the liver on the right because of penetration of air into the abdominal cavity. Appearance of air in the dome of the diaphragm is in most cases detected by a roentgen examination. The patient has an accelerated rapid pulse, but his temperature remains normal during the first day. If the patient is not administered timely aid, generalised peritonitis develops.

In all cases in which sudden and intense pains appear in the upper part of the abdomen, tension in the epigastrium and changes in the pulse, especially if protracted symptoms of gastric disease (heartburn, pains, etc.) were noted before, the patient must be urgently referred to a surgical institution where he may be administered immediate surgical aid. In cases of perforated gastric ulcer only a timely operation (during the first hours after the perforation) may offer any hope of a favourable outcome. The operation usually consists in resection of part of the stomach together with the ulcer or in suturing the ulcer after detection of the point of perforation, when resection is impossible.

Another grave and most frequent complication of gastric ulcer is *gastric hemorrhage* which is particularly dangerous.

The hemorrhage may be single and profuse, in which case the patient at once loses a large amount of blood, but there are also recurring hemorrhages, one hemorrhage following another. The basic measures during gastric hemorrhages are rest and application of ice to the abdomen. To alleviate the pains, atropine is injected, or papaverine 0.02 or Extr. Hyoscyami 0.15, Natrium bicarbonicum, Magnesium bicarbonicum $\overline{aa}$ 15.0, a teaspoonful

three times per day is administered per os. To arrest the hemorrhage, 5 ml of a 10 per cent calcium chloride solution is injected intravenously or 10 ml of normal horse serum subcutaneously and small amounts of blood (hemostatic dose—50 ml), plasma or serum are transfused.

In cases of recurring hemorrhages many surgeons operate during the intervals between the hemorrhages. Surgical treatment is also administered during a profuse hemorrhage with preliminary and simultaneous transfusions of large amounts of blood.

During gastric hemorrhages the diet constitutes a very important problem. The patient is kept on a hungry diet, being given for several days after the hemorrhage only cold water and cold jelly, and is transferred to liquid or gruelly food only on the 5th or 6th day. The lacking amount of nutrient substances and liquid is administered in the form of a glucose solution intravenously or subcutaneously, or in the form of a rectal drip. A system of feeding the patients with gastric hemorrhages from the very first day has been proposed and is being practised. The best results are produced by a mechanically protective diet with a large amount of proteins and fats (Yarotsky and Pevzner's diet).

Care. In cases of perforated ulcer and hemorrhages the patients are not given any baths, laxatives, etc., in preparation for the operation, but are immediately placed in a recumbent position and are delivered to the operating room; it is only necessary to shave the hair on the abdominal skin.

A *cicatricial constriction of the pylorus* (strictura pylori) at first produces increased gastric peristalsis which is perceptible to the eye and is accompanied by sharp pains. At the same time there is a feeling of fullness and pressure in the epigastrium, fetid belching and, towards the evening, vomiting of large amounts of the food consumed during the day and even the day before. The patient notes thirst and constipation; general emaciation and dehydration of the organism develop. A roentgen examination reveals retention of the barium in the stomach and distention of the latter. In cases of pyloric constriction the stomach is systematically irrigated and surgical treatment is administered.

Cancer of the Stomach (cancer ventriculi). Another gastric disease in which surgical treatment is particularly frequently administered is cancer of the stomach. Like most malignant neoplasms this disease is most often observed in elderly people, but may also occur at the age of 30-40 and even earlier. It is not infrequently preceded by gastric ulcer, chronic gastritis or gastric polyps, the latter being considered precancerous.

Glandular carcinoma, solid cell carcinoma and cicatrising cancer (scirrhus) are found in the stomach pathoanatomically. A cancerous affection of the stomach is noted for its tendency

to decompose and ulcerate with subsequent frequent but slight hemorrhages into the lumen of the gastrointestinal tract. Cancer of the stomach spreads quite early to the adjacent organs, lymph nodes, liver and peritoneum. Macroscopically it sometimes looks like a tumour, but most frequently like an ulcer with dense edges; it infiltrates the gastric wall, indurates it and shrinks the whole stomach.

Symptoms: pains, loss of appetite, nausea, vomiting, debility, emaciation (rapidly increasing cachexia), decreased acidity of the gastric juice to the point of achylia, defect of gastric repletion after consumption of the barium meal during roentgenoscopy, positive blood reaction in the feces* and a tumour palpated in the epigastrium. Unfortunately, in cases of such clear diagnosis cancer is usually so widespread that an operation is useless. More important are the initial symptoms: light dyspeptic phenomena (disturbance of appetite, salivation, nausea), sometimes loss of weight and weakness, changes which are revealed by clinical examination (positive blood test in the feces, roentgenological data, changes in the gastric juice, i. e., decreased acidity).

Treatment. Since conservative treatment of cancer can only alleviate the patient's suffering, but does not produce a complete cure, the only thing that can ensure recovery is an operation. Regrettably, surgical intervention is successful only in earlier cases, before the cancerous process has extended to the adjacent organs, i. e., has not produced any metastases. Extreme cachexia, metastases to other organs, particularly the liver, and effection of the inguinal or supraclavicular lymph nodes, and ascites contraindicate surgical treatment.

The operation consists in resection of the stomach with simultaneous excision of all the portions of the great and lesser omentum suspected of cancer, and the lymph nodes contained in them.

Operations on the Stomach. The preparation of a patient for an operation is simple; it consists of a bath on the eve of the operation and of shaving the operative field (if there is no perforation or hemorrhage). Usually the patients are given no laxatives; it is quite enough to administer, on the eve of the operation, a cleansing enema and give the patient light food. On the day of the operation the stomach must be empty. For this reason the patient is given neither food nor drink, and, in cases of poor evacuation of the stomach (pyloric constriction), the stomach is irrigated over a period of several days with a weak solution of hydrochloric acid or water with tincture of iodine.

The main operations on the stomach are: 1) *gastroenterostomy* (formation of a communication between the stomach and the

* The feces are examined for concealed blood only after three days of a meatless diet.

small intestine), 2) *resection* (excision of part of the stomach), and 3) *gastrostomy* (establishment of a gastric fistula).

A gastroenterostomy (Fig. 267) is performed in cancer cases and rarely in cases of gastric ulcer. In ulcers its aims are: 1) to cause the alkaline contents of the upper part of the small intestine (bile and pancreatic juice) to be brought into the stomach and thereby to reduce the high acidity which is one of the causes of ulcer, 2) to provide the chyme with another channel, circumventing the ulcer (pylorus), which diminishes its mechanical irritation and, lastly, 3) to decrease the time during which the food stays in the stomach, which favours reduced secretion of gastric juice and healing of the ulcer. In addition to this, an anastomosis is made in cases in which the passage of food through the pylorus is rendered difficult by a constriction of the pylorus with a cicatrix following an ulcer or by a tumour (cancer).

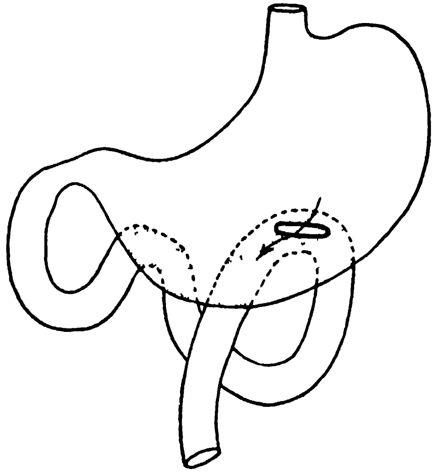


Fig. 267. Gastroenterostomy (diagram)

The anastomosis is made as follows: the adbominal wall is opened along the midline and the stomach is extracted. Then the small intestine, closest to the duodenum (short loop) and the stomach are clamped and the intestine is sutured with a catgut or silk interrupted suture to the posterior wall of the stomach (serous suture). Following this the lumens of the intestine and stomach are opened and the stomach is sutured through the entire thickness of its wall with the intestine by a continuous catgut suture first along the posterior (Fig. 268) and then along the anterior side of the anastomosis (Fig. 269). Now it remains only to cover the anastomosis thus formed by an anterior serous interrupted suture between the stomach and the intestine and to fasten it to the mesentery of the transverse colon (Fig. 270).

The operation of excising part of the stomach (resection) is more complex. Several methods of resection have been proposed.

By one method, after excision of part of the stomach the duodenum is directly connected with the opening of the remaining part of the stomach following the partial suturing of the resected gastric wall. This method is known as Billroth I operation (Fig. 271). By another method the incision of the duodenum is sutured tightly and the stomach is anastomosed with the small intestine

—the Polya-Reichel operation (Fig. 272), Finsterer operation, etc.

Lastly, the operation of producing a gastric fistula is performed in cases of constriction of the cardia or the esophagus after burns and in cancer of the esophagus.

The operation consists in opening the abdominal cavity, pulling out the stomach, sewing a rubber drainage tube, the thick-

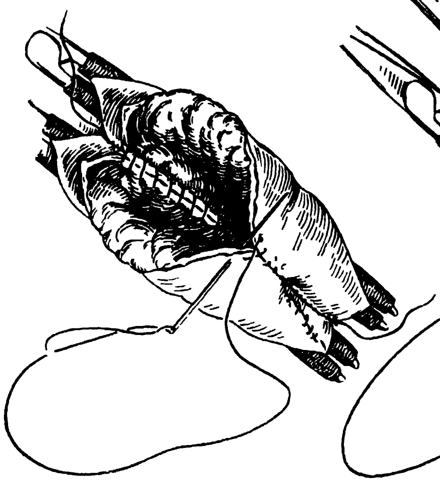


Fig. 268. Gastroenterostomy. Posterior seromuscular silk suture has been applied. Posterior catgut suture is being applied through the entire wall of the intestine and stomach

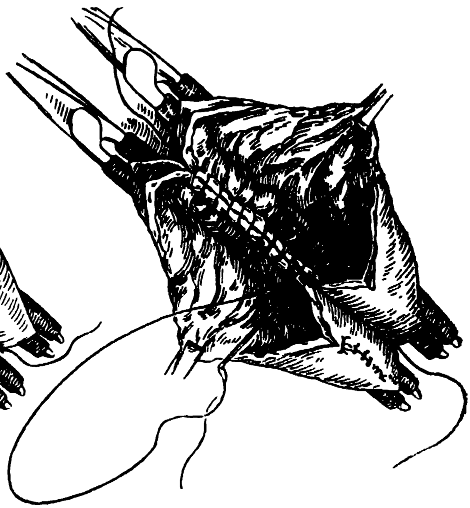


Fig. 269. Gastroenterostomy. Anterior catgut suture is being applied to the entire wall

ness of the little finger, into its wall, one end of the tube being brought out of the abdominal cavity to the exterior and fastened to the abdominal wall, and the other end being inserted in the stomach. Catgut interrupted sutures are made. After this operation, as was described above, the patient is fed through the tube.

Care. During the postoperative period these patients require particular care as grave patients who are threatened with a number of complications. The patients are usually placed in a half-sitting position; during the first night after the operation they are given narcotics (morphine or pantopon in a dose of 0.01 subcutaneously).

Since the chyme may be retained in the stomach after a gastroenterostomy and gastric resection, because of atonia of the gastric wall, with subsequent, sometimes grave, paresis of the stomach, many surgical institutions practise removal of the

gastric contents during the postoperative period. For this purpose a heavy tube is used for irrigating the stomach with small portions (200-300 ml) of water or a thin gastric tube is inserted twice a

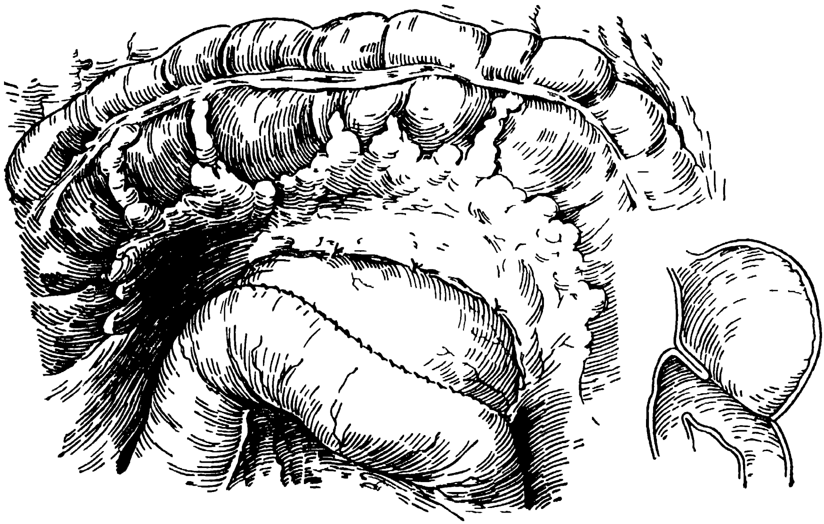


Fig 270. Gastroenterostomy completed. The stomach is sutured to the mesentery of the transverse colon

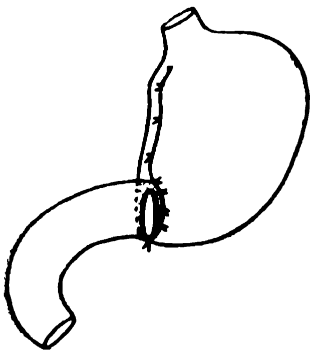


Fig. 271 Billroth I operation

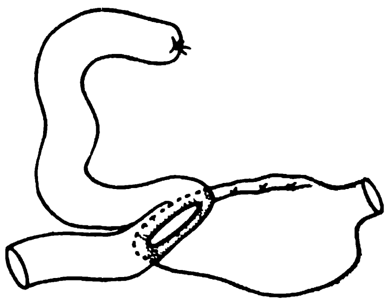


Fig. 272. Resection of the stomach by Polya Reichel's method

day for one hour or even longer to aspirate the contents of the stomach. The thin tube may also be introduced through the nose. During the first day or two the patient is usually administered a blood transfusion by the drip method, glucose and physiologic saline solution to control dehydration of the organism (a total of up to 3,000 ml). The patient must be continuously

watched and in cases of weakened cardiac activity must be administered camphor oil and caffeine.

During the day of the operation the patients are usually given neither food nor drink except those who have a gastric fistula; the latter are given food through the drainage tube (broth, milk, tea) in amounts not in excess of 50 ml each time. On the second day, if the patients do not vomit, they usually begin to be given small amounts of liquid food, preferably cold sweet tea, eggs scrambled with water (protein water) and milk. On the third or fourth day the patients begin to receive liquid and gruelly food (soft-boiled eggs, milk, jelly, broth, thin semolina, mashed potatoes, zwieback, etc., but also in small amounts), and only on the 9th day they are allowed to begin taking more solid food (ground beef, bread, etc.). Depending on the operation and the course of the postoperative period, the diet is changed, but only on the physician's prescription. Since the patients do not receive enough liquid during the first days, they are given subcutaneous or intravenous infusions of glucose and physiologic saline solution, frequently by the drip method, or rectal alimentation.

In addition to feeding, the care of patients with gastric fistulas consists in keeping the drainage tube properly inserted. The canal of the fistula is usually oblique and it is therefore very important that the tube should not come out because it is difficult to reinsert it. The tube may be fastened with a thread tied around the body. However, a tube sewn with a thread leaks at the point of the stitch. It should therefore be fastened as follows: a rubber ring cut off from a heavier tube is set on the tube; a sleeve is formed and the sleeve is sutured. If the gastric content leaks out around the tube, it irritates the skin, and eczemas sometimes develop. In such cases the dressing has to be changed more frequently, and Lassar's paste is applied around the drainage tube.

Complications after gastric operations. In addition to the afore-described complications (hemorrhages, peritonitis) there are also other postoperative complications, namely, gastric atonia and a vicious circle whose main sign is vomiting. The vomiting of blood, sometimes in rather large amounts, observed after a gastric operation, is not dangerous because it is usually the blood that has accumulated in the stomach during or immediately after the operation. But if the vomit begins to show fresh blood in increasing amounts and if the patient turns pale and his pulse drops and is sharply accelerated, it is necessary to take urgent measures against gastric hemorrhage, which consist in application of an ice bag to the epigastric region, subcutaneous administration of morphine and 1 ml of an adrenalin solution (1:1,000) in several ml of physiologic saline solution, subcutaneous in-

jection of horse serum, intravenous administration of 5 ml of a 10 per cent calcium chloride solution and a blood transfusion. Lastly, if these measures prove ineffective, another laparotomy aimed at ligating the bleeding vessel is indicated.

The main sign of a vicious circle and gastric atonia is the failure of the food to pass from the gastric stump into the intestine. The vicious circle is a grave complication of gastroenterostomy in which the food does not pass from the stomach into the anastomosed intestine, but through the duodenum goes back into the adducent loop of the small intestine and from the latter into the stomach (Fig. 273).

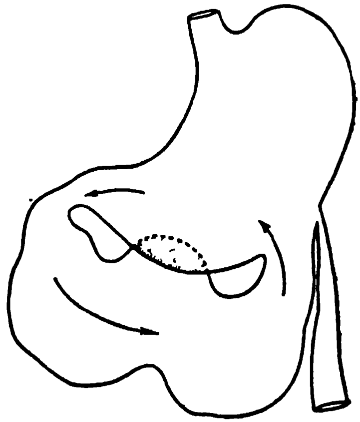


Fig. 273. Vicious circle

If placing the patient on the right side and irrigating his stomach do not help, another operation must sometimes be performed.

In patients operated for gastric ulcer the stitches are removed between the seventh and ninth day and in cases of cancer of the stomach, especially in very weak patients, it is best to remove the stitches somewhat later, i. e., on the fourteenth or fifteenth day, which diminishes the danger that the edges of the wound in the abdominal wall may part. The nurse must never forget this dangerous postoperative complication. Therefore, if the dressing has become soaked after removal of the suture following an operation in the abdominal cavity, especially a gastric operation, the first chances are that the edges of the wound in the abdominal wall have parted. There is no reason for complacency under the impression that the dressing may be soaked because of suppuration of the wound or hematoma of the abdominal wall, especially if the dressing is saturated with a light-coloured fluid; it is necessary to examine the region of the operation by removing or slightly raising the dressing. Sometimes there is only a slight parting of the skin edges of the wound under which the intestinal loops can be seen, but in some cases the intestinal loops prolapse from the abdominal cavity and are directly under the dressing. If the abdominal wound has opened, an urgent operation is immediately performed because any delay threatens inflammation of the peritoneum. The operation consists in bathing the prolapsing intestinal loops in warm physiologic saline solution, their return to the abdominal cavity and new suturing of the abdominal wall.

Of the diseases of the abdominal organs subject to surgical treatment we shall additionally mention several benign and malignant tumours. In cases of tumours the picture of the disease varies, depending on whether or not it affects the intestines. In the latter case the disease takes the form of chronic intestinal obstruction (alternation of constipation and diarrhea, and intense pains accompanied by increased peristalsis); after passage of the contents through the constricted place, the pains subside. Sometimes attacks of real intestinal obstruction occur. Fluoroscopy and roentgenography are used to ascertain intestinal patency.

The postoperative management of the patient varies depending on whether or not the intestinal lumen was opened during the operation. If it was, the patients are managed as after intestinal resection, and if it was not—in most cases as after an operation for chronic appendicitis. Owing to the complexity of interventions in the abdominal cavity during laparotomies and the variety of diseases, the nurse must be given precise instructions by the operating surgeon with respect to managing the patient.

Intestinal Obstruction (ileus). Intestinal obstruction, or ileus, is a syndrome which appears when the intestinal contents fail to be propelled along the intestinal tract. The vivid picture and the gravity of this syndrome frequently overshadow the main disease which has caused it.

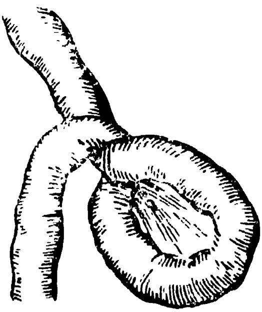
Etiology. The propulsion of the intestinal contents along the intestine may discontinue for many reasons, i. e., as a result of mechanical difficulties (*mechanical ileus*) and disturbances in innervation of the intestines involving disorders of their motor function (*dynamic ileus*).

Only mechanical disorders of intestinal patency are subject to surgical treatment. These include *compression of the intestinal loop by some tumour*, *inflammatory process*, *cicatricial cord*, *obstruction of the intestinal lumen by tumours* (for example, cancer of the intestine), etc. *Twists of the intestinal loops* (Fig. 274) or *formation of knots from the intestinal loops* (Fig. 275), *internal strangulation of an intestinal loop* (for example, adhesions in the abdominal cavity [Fig. 276]) and *passage of one part of the intestinal loop into another* (intussusception, Table XI) also play an important practical part.

Pathologic anatomy. In cases of compression of the intestinal loop, especially together with the mesentery (*strangulation ileus*), characteristic changes occur in the intestine. Circulatory disorders and, primarily, difficulties of venous outflow give rise to hemorrhages in the wall, and the nutrition of the intestinal

wall is disturbed; a fluid passes into the lumen of the intestine and accumulates there, the muscles of the intestine become paralysed, decomposition of the intestinal contents is accelerated, absorption is disturbed and, owing to formation of gases the intestine is, as a rule, greatly inflated. During the subsequent course of the disease fluid begins to penetrate together with bacteria through the intestinal wall into the abdominal cavity, in which case total or partial necrosis of the loop and general peritonitis are observed.

In cases of intestinal obstruction, for example by a tumour



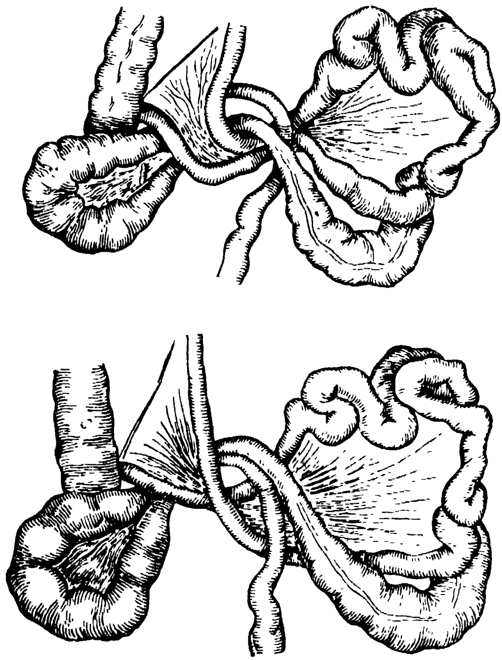


Fig Ileus

Fig. 275. Knot of intestinal loops

(*obturation*), the pathoanatomical changes occur later. They consist initially in hypertrophy of the intestinal wall above the site of obstruction, increased peristalsis and, if the constriction progresses, in atonia and intestinal distention, which may produce ulceration, necrosis and perforation of the intestine with subsequent peritonitis.

In intestinal obstruction, long before complete development of the local changes in the intestinal loop, grave general intoxication (poisoning) of the organism by the decomposing intestinal contents occurs with subsequent degeneration of the internal parenchymatous organs. The intoxication is most strongly pronounced in the strangulation form of intestinal obstruction; it occurs the sooner, the higher along the intestinal tract the obstruction is. The reason for intoxication and rapidly resulting death in intestinal obstruction is not quite clear. Dehydration

of the organism, intoxication from the intestines, irritation of the mesenteric nerves, changes in the blood supply to the abdominal organs, impoverishment of the organism in sodium chloride salts and several other causes are of some significance.

Symptoms. Strangulation ileus begins with sharp pains throughout the abdomen, nausea and vomiting. Subsequently the pains become more intense. The gases cease to be discharged, there is no defecation, the patient's face pales, the pulse is sharply accelerated, and cyanosis not infrequently appears. Examination of the abdomen reveals extreme distention; on percussion the abdomen sounds like a drum, the abdominal walls are tense, but are not very painful to touch. Hepatic dullness is reduced because the intestines displace the liver upward and raise the diaphragm; percussion of the abdominal wall produces a splashing sound. As a rule, the temperature in the initial stage of ileus is not elevated.

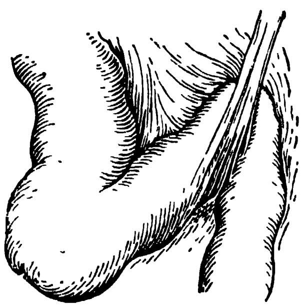


Fig. 276. Compression of intestinal loop by a chord

In cases of obturation (ileus in which the intestinal lumen is obstructed) the clinical picture of intestinal obstruction develops less violently and less rapidly. As in cases of strangulation ileus, the feces and gases are retained; in the beginning increased peristalsis of the intestinal loops accompanied by pangs is observed. The peristalsis is perceptible to the eyes through the abdominal integuments. In this form the patient vomits at later periods and the vomit frequently smells of feces. Phenomena of intoxication occur much later. Fluoroscopy with introduction of barium through an enema reveals arrest of the contrasting mass in the region of the tumour (Fig. 277). Barium administered per os is retained above the tumour or produces a defect of repletion.

A somewhat different picture is produced by intussusception most frequently observed in children (Table XI).

Intussusception is the most important form of intestinal obstruction in children, especially infants. The passage of the small intestine into the cecum occurs most frequently. Intussusception may be acute or chronic. Its signs are as follows: appearance of colicky pains, vomiting, and retention of the stool and gases. The pains cause small children to scream and cry, and make them restless; the children grow pale and break out in a cold sweat; sometimes they are greatly weakened. Such attacks recur after short intervals; sometimes the gases and feces are discharged. A discharge of sanguineous mucus through the anus is characteristic of intussusception (this should not be confused

with bloody diarrhea in dysentery in which, contrary to intussusception, pyrexia is in most cases observed in the beginning of the disease). The abdomen is soft to touch and sometimes, corresponding to the site of intussusception (in the right iliac region) a sausage-shaped tumour sensitive to pressure is palpated.

The sick child is referred for an urgent operation; the sooner the operation is performed, the better the prognosis, and, contrariwise, the later the operation is undertaken, the worse its results.

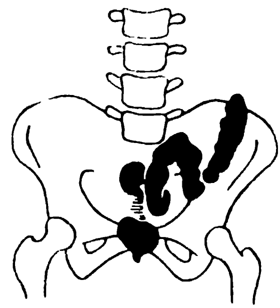


Fig. 277. Cancer of the lower part of the sigmoid colon. Defect of sigmoid colon repletion

Dynamic (*spastic*) *ileus* usually runs a less violent course; in cases of paralytic ileus the anamnesis reveals inflammatory processes in the abdominal cavity, traumas, reflex influences, etc. The pains are usually milder, frequently there is no vomiting, the obstruction is incomplete. General meteorism is noted; high enemas produce certain results.

Treatment. First aid in intestinal obstruction consists in repeated high and syphon enemas and subcutaneous injection of atropine. If these measures fail, an operation is necessary.

In cases of functional intestinal obstruction no surgical intervention is usually indicated, but a Vishnevsky novocain block is administered.

In ileus, as in other acute diseases of the abdominal cavity, no narcotics (pantopon, morphine) should be administered before the diagnosis or an indication for operation has been established, because they obscure the picture of the disease. Administration of laxatives is a serious mistake since they greatly aggravate the patient's condition and affect the outcome of the operation. High enemas are of enormous importance for diagnosing and treating intestinal obstruction. The enemas are administered as follows: the bed or table are covered with an oilcloth; the patient is placed on his left side or on his back with a bedpan under him and a soft rubber nozzle is carefully inserted in the anus at least 8-10 cm deep, making sure that it does not bend in the rectal ampulla. The water is administered slowly, the bottle being raised more than 1 m above the level of the patient. The water must be lukewarm. After removal of the tube the patient is laid or seated on the bedpan. Free entrance of one and, especially, two bottles of water attests that the patency of the large intestine has not been disturbed. If only a small amount of liquid gains entrance and clean water without gases is immediately discharged, it indicates obstruction of

the large intestine, particularly the sigmoid flexure of the colon. If gases and turbid water containing pieces of fecal matter are discharged and the patient is relieved, the enema should be repeated several times. In cases of incomplete obturation it is sometimes possible to bring the patient out of the state of ileus, if not directly after the enema, then within a certain period (half an hour to an hour) of time.

In cases of intestinal paresis, intestinal tumours and other forms of intestinal obstruction the best effect is produced by syphon enemas. Rubber tubes up to 2 m long (a gastric tube connected with a drainage tube on which a funnel is set) are used for syphon enemas. The patient lies on his back or on his left side on the procedure table or the wheeled stretcher. The end of the rubber tube is abundantly coated with vaseline and is introduced into the rectum. Room-temperature water is poured into the funnel and the latter is raised 1-2 m above the level of the patient. As the water enters the intestine, the tube is advanced to a depth of 50-80 cm.

As soon as almost all of the water has entered the intestines, the funnel is quickly lowered and held in this position until the water and intestinal contents fill the funnel. If the water is clean, the funnel is raised again and the procedure is repeated. As the funnel is lowered, no water should be poured out until the funnel is completely filled. It is thus ascertained whether or not all the water introduced into the intestines has been discharged.

If the water contains fecal matter, it is poured out and clean water is poured in. Not all the water should be poured out of the funnel to avoid introducing air bubbles into the intestines when water is poured into the funnel, because it will not be clear whether bubbles of gas or bubbles of the air driven into the intestines are being discharged.

If the obstruction is located low or the rubber tube is twisted in the intestine, the water goes past the tube.

After making sure that the tube has been properly inserted by introducing a gloved finger into the rectum, the administration of the syphon enema is continued.

A syphon enema may be considered effective if gases are discharged and the cleansing water contains diluted feces.

To make syphon enemas effective, it is sometimes necessary to administer them for a period of one or one and a half hours, changing a good deal of water. Successfully administered syphon enemas give the patient relief and sometimes produce a complete cure.

It is very important not to waste too much time on conservative measures because each wasted hour serves to aggravate the conditions for the operation. If the enemas prove ineffective, especially if the water does not enter the intestine at all and is

quickly ejected, it is necessary to resort to surgical treatment as soon as possible.

The operations may differ very greatly, depending on the causes of the obstruction. In addition to a simple unwinding of the intestines (Fig. 278) and dissection of the adhesions, intestines are sometimes anastomosed in order to by-pass the point of constriction; in cases of necrosis of the intestinal loop the latter is resected.

In cases of resection (Fig. 279, *a*) the mesentery of the intestine is ligated, the affected intestine is transected and removed. After this both ends of the transected loop may be connected end to end (Fig. 279, *b*, *c*, *d*, *e*) or tightly sutured and the intestinal loops may be anastomosed side to side (Fig. 280), or one end

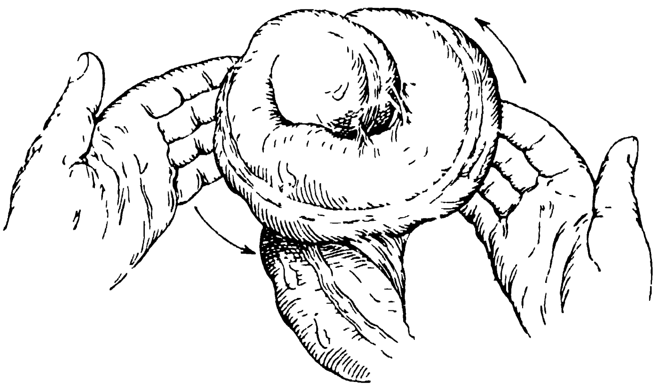


Fig. 278. Untwisting the intestine in a case of ileus

may be closed and the other sutured to the lateral wall of the adjacent loop (end-to side connection).

Lastly, in some cases, for the purpose of solidifying the intestinal contents, a so-called preternatural anus is made, i.e., two transected ends of the intestine (most frequently the sigmoid flexure of the colon) are sutured to the abdominal wall, the feces being excreted into the dressing. Sometimes a fecal fistula is applied, in which cases an opening is made in the intestinal wall and the opening is sutured to that of the abdominal wound. In such cases the intestinal contents may be propelled as usual along the intestinal tract and be partly excreted into the dressing.

Care. Preparation of the patient for the operation consists in shaving the operative field, administration of enemas and, if necessary, cardiacs and infusions.

It is particularly important to administer to the patient large amounts of sodium chloride both before and after the operation.

Sodium chloride is administered subcutaneously in physiologic saline solution.

Before operations on intestinal obstruction the stomach must be irrigated.

After operations for intestinal obstruction the patients are usually in a serious condition due to intoxication. Paresis of

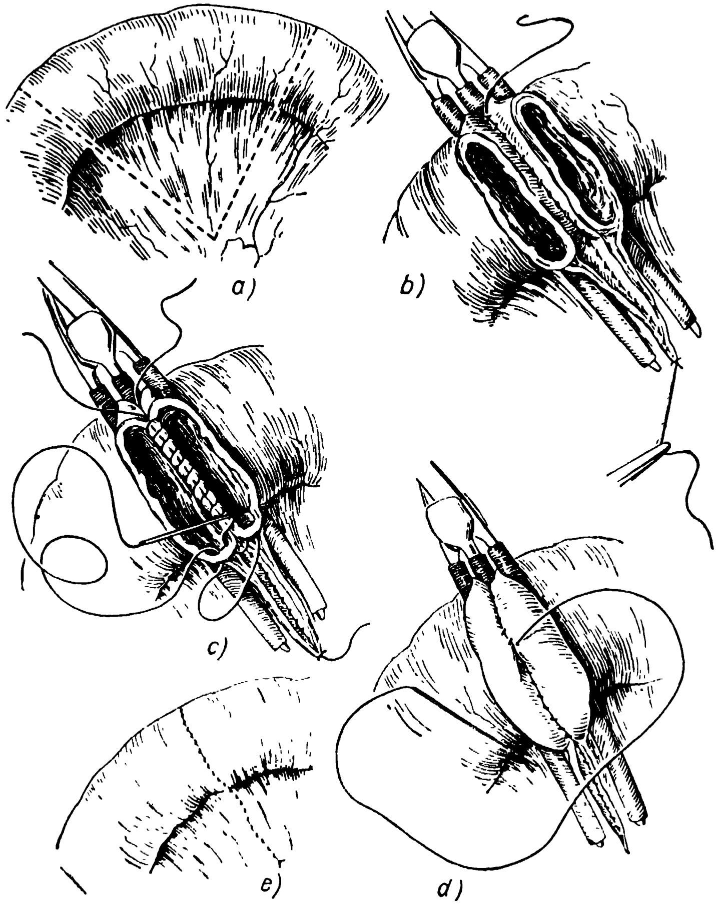


Fig. 279. End-to-end intestinal anastomosis

the intestines and stomach caused by the disease, as well as by the operation, is observed for some time following the operation. This necessitates particular attention in the care of such patients. In addition to general measures, the patients are administered syphon enemas for the purpose of stimulating discharge of the gases. After resection of the small intestine enemas must be employed sparingly, i.e., they must be administered only in cases

of extreme necessity, no more than 100-200 ml of liquid being introduced at one time; the attending personnel must see to it that all the water is discharged. After resection of the colon

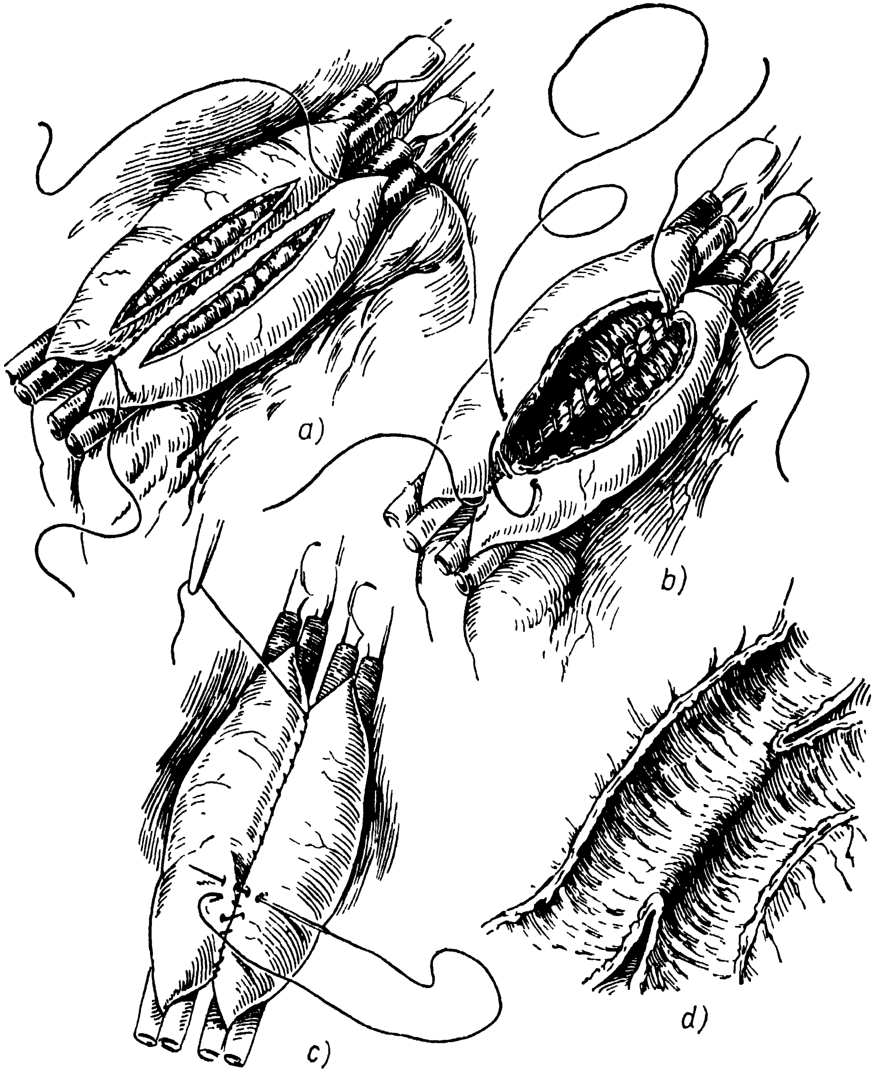


Fig. 280. Side-to-side intestinal anastomosis

(sigmoid, etc.) enemas are contraindicated because administration of large amounts of water is conducive to parting of the intestinal stitches and the water gains entrance into the abdominal cavity. The best method to produce intestinal peristalsis is intra

venous administration of a 10 per cent solution of common salt (20-30 ml three times a day during the first 2-3 days after the operation) and subcutaneous administration of eserine (Sol. Eserini 1 : 1000, 1.0). In cases of intestinal paresis irrigation of the stomach must not be neglected because of the large amount of fluid which always accumulates therein.

To encourage rapid excretion of the poisons absorbed from the intestines, large amounts (1,000-2,000 per day) of physiologic saline solution are administered by the drip method intravenous-

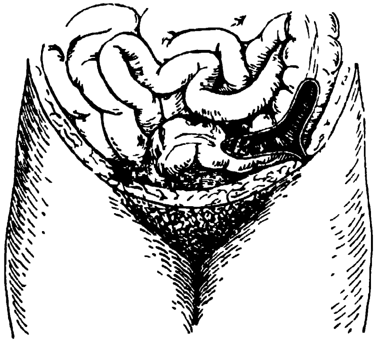


Fig. 281. Intestinal fistula

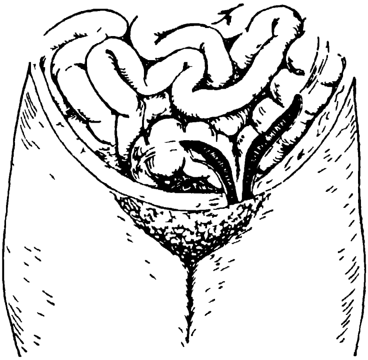


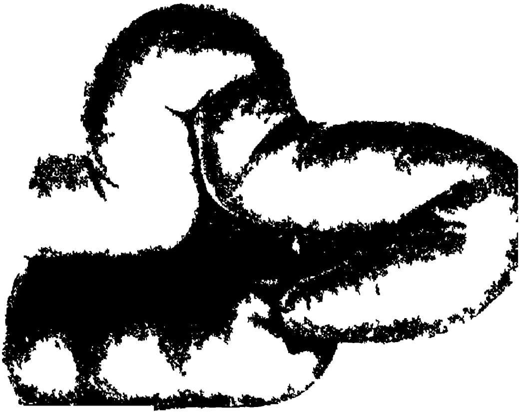
Fig. 282. Preternatural anus

ly, or subcutaneously and cardiac activity is supported (camphor, caffeine).

All these measures eliminate intestinal paresis which is in itself dangerous even after elimination of the mechanical obstruction of the intestinal tract because it produces intoxication, impairs the intestinal barrier, facilitates penetration of the microbial flora into the peritoneum and favours development of peritonitis.

Intestinal Fistulas. Intestinal fistulas (Fig. 281) are among the very grave diseases requiring thorough care. They arise most frequently as a result of intestinal strangulation or injury. Sometimes a preternatural anus is made during the operation (Fig. 282). This is done in cases in which it is necessary to provide an outlet for the intestinal contents (operations for cancer of the intestines, rectum, etc.). When it is necessary to prevent infection with the intestinal contents in the process of the operation, such fistulas are made beforehand.

The subsequent care of the patient with a preternatural anus is the same as in cases of fecal fistulas following intestinal injury or strangulation. To prevent development of eczema, the skin surrounding the fistula is carefully protected at the time of dressing against its possible irritation by the intestinal con-



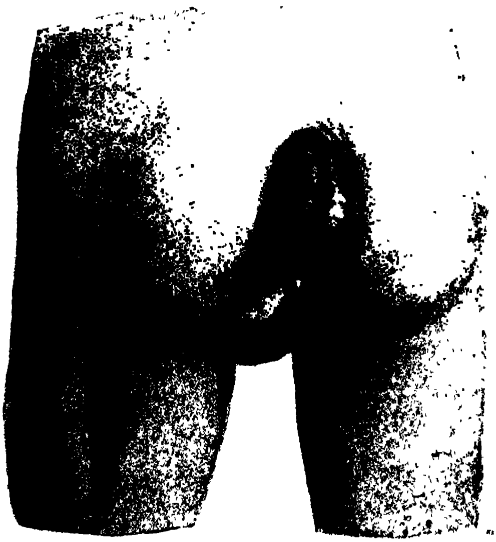
a

b

a—Intussusception of the small intestine
b—Gangrene of the intussuscepted part

TABLE XII

External and internal hemorrhoids



Rectal prolapse

tents. For this purpose ointment dressings and Burow's• lotion are applied to the skin; lastly, the fistula is managed openly, i.e., the patient is placed under a frame, is given a piece of cotton and a pan, and is taught to wipe off the discharge from the fistula with the cotton.

The higher along the intestinal tract the fistula is located, the more it irritates the skin, since the contents of the upper portions of the intestines possess digestive activity because they contain intestinal juices (bile, trypsin).

DISEASES OF THE RECTUM

Many different pathological processes in the rectum, including deformities, inflammatory diseases (paraproctitis), hemorrhoids, fistulas, fissures and cancer are treated surgically.

Atresia of the Anus and Rectum (atresia ani et recti). The frequent congenital diseases include improper development of the rectum consisting in the absence of an anal opening or the presence of a membrane separating the rectum from the anus. The portion of tissue responsible for the rectal obstruction may consist of a thin membrane, but sometimes may be 1-2 cm thick. In some cases this imperfect development is accompanied by formation of fistulas between the blind end of the rectum and the urinary bladder in boys and between the blind end of the rectum and vagina in girls.

The main symptom of complete anal obstruction is failure of the meconium (the first fecal discharge of the newborn) to be voided. If this anomaly is not noticed in due time, the child rapidly develops phenomena of intestinal obstruction, namely, vomiting, extreme abdominal distention, dyspnea and cyanosis. If no surgical aid is administered, the child dies within four to six days.

The existence of a sufficiently wide fistula between the rectum and vagina excludes immediate danger to life, whereas a fistula into the urinary tract of boys admits microbes into the latter and rapidly leads to the child's death.

The only recourse in cases of underdevelopment of the anus and rectum is an urgent operation, not later than on the second day of the child's life, i.e., before phenomena of obstruction have developed.

Paraproctitis. A purulent inflammation of the subcutaneous tissue surrounding the rectum is called paraproctitis.

The infection usually penetrates into the tissue from ulcerated hemorrhoids and fissures in the anal region. The process is similar to that of an abscess (Fig. 283) which opens into the rectum or through the skin surrounding the anus. Such limited forms

of paraproctitis may be subcutaneous and submucous. Paraproctitis is much more severe if it runs the course of a phlegmon, sometimes involving the subcutaneous tissue along the entire periphery of the rectum and accompanied by considerable mortification of tissue (septic and gangrenous paraproctitis).

The general symptoms of paraproctitis are the same as of any purulent disease, namely, pyrexia and changes in the blood (leukocytosis). In cases of highly located paraproctitis these are the basic symptoms. In cases in which the process descends to the anus, as well as in the more common forms of paraproctitis, the local phenomena are also strongly pronounced. They consist in intense pains, especially during defecation, difficulties in defecation, and, what is most important, appearance of a swelling noticeable from the outside and easily identified by examination of the rectum with a finger. During later periods of the disease odema and redness near the anus, softening of the infiltrate and appearance of fluctuation are observed. From the very beginning of the disease the intestines are purged with laxatives and the patient is transferred to a light diet which produces little feces. At first an ice bag is applied to the region of the anus and on the second or third day thermal procedures (warm sitz baths, hot water bottles and microenemas) are prescribed to accelerate the process. Microenemas are administered as follows: 100 ml (half a glassful) of physiologic saline solution or a camomile tincture at 40-42°C is poured into a rubber balloon and then slowly administered into the rectum. If the patient tolerates such microenemas well, the latter may be made hotter. A microenema must be completely absorbed without producing intestinal action. Such enemas are administered up to five times per day. The rubber nozzle of the balloon must be inserted very carefully, not to cause any pain; to diminish pains during paraproctitis, suppositories with belladonna are used.

Fig. 283. Localisation of pus accumulation in paraproctitis

It is not advisable to wait until the abscess opens spontaneously because in such cases fistulas persist more frequently (see below). It is best to open the abscess surgically. Before the operation it is necessary to put the patient on a light diet, evacuate the bowels with a laxative, and on the day of the operation to give the patient an opium tincture (eight drops per dose) and a bath, as well as a shave of the region of the anus and perineum.

The operation is usually performed under local anesthesia, the abscess being incised radially in relation to the anus.

The subsequent dressings are made daily and additionally changed after defecation. To retain the stool, an opium tincture (eight drops two or three times a day) is sometimes administered

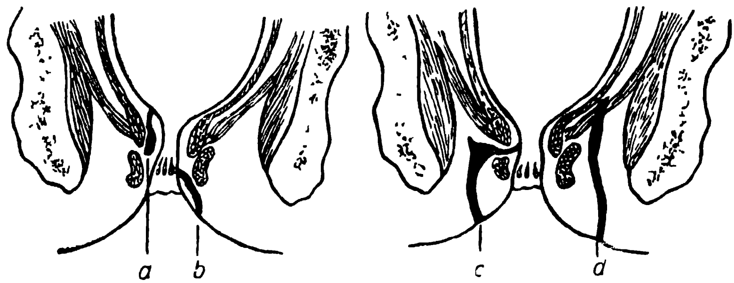


Fig. 284 Rectal fistulas

for 3-4 days and a light diet is prescribed (until the first stool). To facilitate defecation, the patient is daily given a mild laxative (Pulv. rad. Rhei 0.3 or 1 2 tablets of purgen) beginning on the 4th or 5th day. The disease terminates within several weeks, but tends to relapse.

Perirectal Fistula. A perirectal fistula is a narrow, sinuous canal covered with granulations in the region of the anus (Fig. 284); it opens either to the exterior (Fig. 284, *c*, *d*) near the anus or into the rectum (Fig. 284, *a*), and sometimes in both directions (Fig.284, *b*).

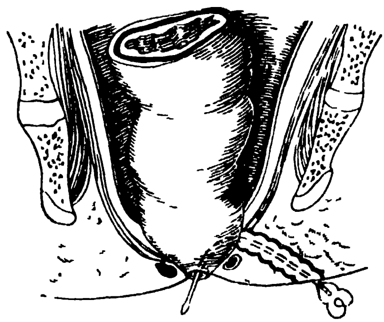


Fig. 285. Introducing a probe into a complete fistula

Fistulas which establish communication between the external integuments and the rectum are called complete (Fig. 285). A fistula running from the mucosa into the depth of tissues is called an incomplete internal fistula, and one running from the skin into the depth of the tissues—an external incomplete fistula. The patient is usually discomforted by a purulent discharge, irritation of the skin near the anus, pain during defecation and sometimes (in cases of fistular constriction) symptoms simulating paraproctitis. This disease does not terminate without an operation. The operation consists in excision or resection of the fistula.

The preparation and care of the patient are the same as for operations on hemorrhoids (see below).

Anal Fissures. Mention must also be made of *fissures* in the anal region (Fig. 286). Old fissures have callous, dense edges; they display little tendency to healing and are easily injured during defecation. Owing to stimulation of the nerve endings in the region of a fissure during defecation the sphincter reacts with a painful spasmodic contraction.

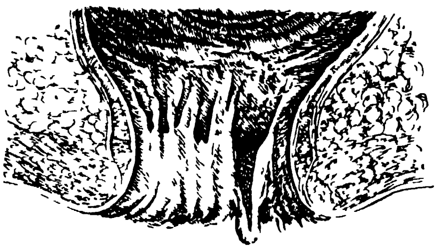


Fig. 286. Anal fissure

The pains in cases of anal fissures are very intense usually after defecation. Fearing pain the patient retains the stool and develops constipation. The coarse fecal masses forming in such cases injure the fissure during defecation and hinder it from healing. Patients with a highly excitable nervous system are greatly discomforted by this disease which sometimes causes them severe suffering.

The *treatment* consists in continued administration of laxatives and regulation of the diet to produce a gruelly stool.

The pains not infrequently subside under the influence of thermal procedures after defecation (warm baths in the anal region and hot water bottles). Lastly, ointments with anesthetising substances and suppositories with belladonna are administered for anal fissures. Sometimes the fissure is cauterised with silver nitrate after anesthesia (2 per cent dicaine solution). If conservative treatment proves ineffective, surgical treatment is resorted to; the latter consists in extensive dilation of the sphincter (under local anesthesia). This dilation causes paresis of the sphincter, owing to which its spasm disappears; during the few days it takes the sphincter to return to normal the fissure heals. In some cases the fissures with callous edges are excised under local anesthesia and the edges of the wound are joined by sutures. The preparation of the patient for the operation and the care of the patient are the same as in cases of hemorrhoids.

Hemorrhoids (varices haemorrhoidales). Hemorrhoids imply a varicose enlargement of the veins of the lower portion of the rectum and of the anal region. If the submucous veins are enlarged above the anal sphincter, the hemorrhoids are called internal; if the enlarged varicosities are under the skin of the anal region, the hemorrhoids are called external (see Table XII).

The *reasons* for the enlargement of the veins in the lower portion of the rectum are low tone of the vascular wall caused by disturbances in innervation and weakness of the vascular wall,

difficulty in the outflow of the venous blood in the rectal region and the resultant stasis. A very important role is also played by the chronic inflammatory changes in the walls of the veins, which are not infrequently due to extension of the inflammatory process from the rectal mucosa.

Anything that renders difficult the outflow of blood from the abdominal organs, the rectum in particular, may cause a varicose enlargement of its veins, i.e., hemorrhoids. These factors include a sedentary occupation, hard physical labour associated with lifting weights, and chronic constipation. Nor can the role of inflammatory diseases of the intestinal wall be overlooked. Hemorrhoids most frequently affect males.

Pathological anatomy. In hemorrhoids there is a varicose enlargement of the veins and a thinning of their walls which frequently adhere to the intestinal mucosa and rupture so that the blood effuses into the rectum and through the anus to the exterior. In some cases the blood in the varicosity coagulates, the varicosity becomes *thrombosed* and subsequently, during resorption of the thrombus, becomes *obliterated.* If infection gains entrance into such a thrombosed varicosity, the latter develops an *inflammation* which in some cases ends in decomposition of the thrombus, appearance of an abscess and, subsequently, ulceration of the varicosity. From such an ulcerated inflamed varicosity (and sometimes from a fissure in the region of the anus) the infection may penetrate into the subcutaneous tissue about the rectum, in which case the afore-described abscess near the rectum (paraproctitis) is formed. In some cases the hemorrhoids located above the sphincter of the rectum come out to the exterior during defecation and are strangulated by the sphincter. This may cause mortification of the strangulated hemorrhoids owing to circulatory disorders in them.

Symptoms. The main symptom of the disease most frequently indicated by the patients is *hemorrhoidal bleeding*. The bleeding occurs almost exclusively during defecation when, owing to injury by the passing fecal masses and increased intraabdominal pressure resulting from straining, the distended capillaries of the mucosa rupture. In some cases the feces are only coloured by a few drops of blood, but sometimes as much as half a glassful of blood, or even more, is discharged. If the bleeding is not profuse, it sometimes recurs daily for a period of many years, having very little effect on the patient's general condition. Contrariwise, profuse and frequent hemorrhages lead to extreme forms of anemia. Only in exceptional cases can a hemorrhage be so profuse and protracted as to endanger the patient's life. In addition to the bleeding, the patient also notes pain and prolapse of the varicosities during defecation, itching in the region of the anus and constipation. Sometimes these symptoms prevail when there

is hardly any bleeding. It must never be forgotten that cancer of the rectum may have similar symptoms and therefore only a most careful examination of the patient by insertion of a finger into the rectum, as well as by rectal speculum or rectoscope (for cancerous tumours situated high) can establish the absence of the latter disease.

Prophylaxis. To prevent the development of hemorrhoids and their complications, an appropriate regimen with enough physical exercise and proper nutrition which precludes constipation is of some importance. Prevention and proper treatment of gastrointestinal diseases also play an important part.

Treatment. Appropriate diet, working habits and exercise may eliminate the inflammatory phenomena in the region of the rectum and the phenomena of stasis in the region of the rectal veins. It is often possible to do away with all the unpleasant symptoms by therapeutic treatment, and hemorrhoids sometimes cease to discomfort the patient for a long period of time. It is necessary to eliminate constipation (diet: sour milk, stewed fruit, prunes, cabbage, fresh salads, porridge), and administer cold local baths or merely to wash the region of the anus with cold water every day and, lastly, to insert in the anus suppositories with belladonna (Extr. Belladonnae 0.015 Butyri Cacao q. s. ut fiat suppositorium).

Complications. Strangulation of the hemorrhoids occurs when they come out to the exterior during defecation, and contraction of the sphincter prevents them from reentering the rectum. Soon afterwards the patient experiences pain, but the hemorrhoids are still soft to touch. Then, owing to a disturbance in circulation the varicosities become thrombosed and dense. Intense compression disturbs the nutrition of the tissues and the varicosity necrotises, while an inflammation with a dense infiltrate develops about the anus and in the submucosa of the anal tissue.

Strangulation of hemorrhoids, if it has only just occurred, is eliminated, the hemorrhoids being carefully replaced in the rectum. In cases of strangulation of several hours' duration, when the hemorrhoids have become thrombosed and are dense to touch, the patient is put to bed and is prescribed warm sitz baths and daily laxatives (1-2 teaspoonfuls of licorice powder). The region of the anus is sponged with a warm boric acid solution and is coated with vaseline oil daily, sometimes twice a day or, at any rate, after each defecation.

In *thrombosis* and *inflammation* of hemorrhoids there are sharp pains in the region of the anus. The hemorrhoids become dense and very painful, and edema is not infrequently observed around them. The patient is prescribed laxatives and suppositories and is put to bed; during the first days of the disease cold (lotions

and an ice bag) and subsequently heat (hot water bottles) for rapid resorption are applied to the anal region.

Surgical treatment. In cases of severe, stubborn and protracted hemorrhoids *surgical treatment* is resorted to. It usually consists in suturing and ligating the hemorrhoids after clamping them with hemorrhoidal clamps (Fig. 287). Persistent hemorrhages, continuous pains during defecation and recurring complications in the form of prolapse, strangulation or thrombosis of the hemorrhoids serve as an indication for operation. An operation is performed after elimination of the complication. No operation should be attempted during strangulation, thrombosis or inflammation of the hemorrhoids because of possible disengagement of the thrombus, embolism or spread of the infection and development of a phlegmon about the rectum.

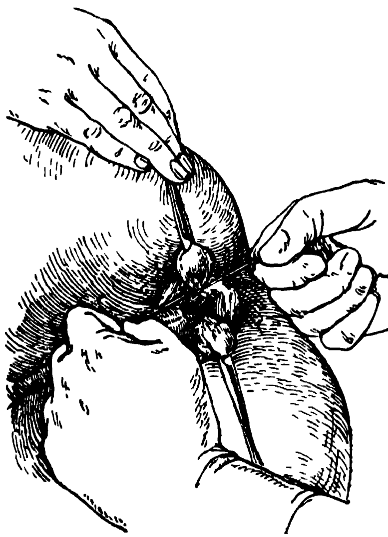


Fig. 287. Ligation of hemorrhoids

Preparation for the operation consists in the following: two days before the operation the patient is put on a light diet and one day before the operation is administered a laxative; on the eve of the operation the patient is given an enema; in the evening preceding the operation and in the morning of the operation day the patient is administered 5-8 drops of an opium tincture. During the postoperative period the patient must be prescribed for five days a diet producing little fecal residue (sweet tea, coffee, broth, jelly); at the same time the patient continues to take the opium tincture (5-8 drops three times per day).

The prophylaxis of the disease envisages exclusion of all factors favouring appearance and enlargement of the varicosities (constipation, sedentary life, lifting heavy weights, etc.). Hence, concern about proper functioning of the intestines, treatment of constipation, an appropriate working regimen and physical culture are the main measures aimed at preventing hemorrhoids. Timely and careful treatment of hemorrhoids is necessary to prevent graver complications, i.e., thrombosis, paraproctitis, etc.

Tumours of the Rectum. The tumours most frequently occurring in children are polyps. They never cause any discomfort,

but in some cases, when ulcerated, bleed and during defecation prolapse from the anus in the form of pedunculated tumours, externally resembling a cherry (Fig. 288).

The *treatment* consists in surgical removal of the polyps. The preparation for the operation and the postoperative care are the same as in operations for hemorrhoids.

Cancer of the Rectum is the most frequently occurring malignant tumour. Among the other localisations of cancer it holds fifth place as regards incidence and constitutes up to 80 per cent of all cases of intestinal cancer. Cylindrical cell carcinoma originating from the mucosa and squamous cell carcinoma originating from the skin of the anal region are distinguished. The tumour becomes quickly ulcerated and assumes the form of an ulcer with dense edges and a dirty floor (Fig. 289). As the tumour grows it causes progressive constriction of the intestinal lumen. The annularly cicatrising tumour continues to spread and extends to the adjacent organs, the urinary bladder in particular (where it produces metastases to the inguinal and retroperitoneal lymph nodes), the liver and other distant organs.

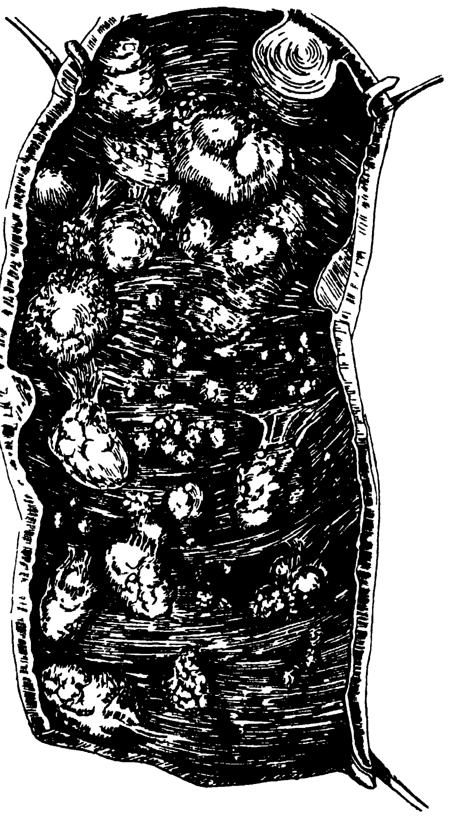


Fig. 288. Rectal polyps

The first *symptoms* are very much like those of hemorrhoids, namely, constipation, diarrhea with tenesmus, pains during defecation and blood in the feces.

The diagnosis, as was mentioned above, can be made only by digital examination and by examination with the rectoscope; it is therefore necessary, whenever there is a complaint of anal hemorrhage, to examine the rectum with the finger.

Surgical treatment is possible if there are no metastases. The operation is performed either through the perineum and the sacrum, or (more frequently) through the abdominal cavity. During the operation it is sometimes impossible to retain the

sphincter and a preternatural anus has to be made in the abdominal wall.

The rectum is either excised together with the sphincter (amputation) or part of the rectum is excised while the sphincter is retained (resection).

In the first case the operation is sometimes performed in two stages; a preternatural anus is made first and the rectum with the tumour is excised only some time after the wound has healed.

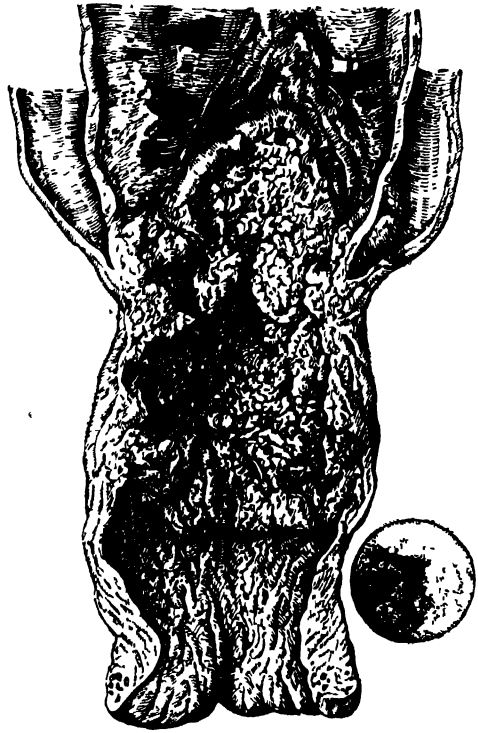


Fig. 289. Cancer of the rectum

This operation must be very carefully prepared; the intestines are cleansed with a laxative two days before the operation, then enemas are administered and the rectum is irrigated; in the evening preceding the operation the patient is given an opium tincture.

The postoperative management depends on the character of the operation, the preternatural anus requiring particular care (daily dressings).

Several complications are possible during the postoperative period, including generalised peritonitis and local purulent infection; the latter is difficult to avoid when operating on an organ so greatly abounding in microbes as the rectum. Usually, after the operation the wound in the perineum or sacral region is not sutured, but tampons are used, which requires very careful and complex dressings.

Prolapse of the Rectum. Prolapse of the anal mucosa and prolapse of the rectum involving the entire thickness of its wall (Table XII) are distinguished. It should not be forgotten that the patient may sometimes regard the prolapsed hemorrhoids as rectal prolapse.

Prolapse of the rectum in children is most frequently caused by diseases of the intestines—protracted summer diarrheas accompanied by straining during defecation and intense straining

in cases of phimosis and vesical calculus. In adults prolapse of the rectum is caused, in addition to intestinal diseases, by disorders of innervation, weakening of the pelvic floor and increased intra-abdominal pressure. Two forms of rectal prolapse are distinguished—reducible and irreducible; the former appears only during defecation and sometimes during physical effort, and the latter, graver form, is accompanied by ulceration of the mucosa, edema of the rectum, and sometimes gangrene and generalised peritonitis.

In cases of rectal prolapse the rectum must be pushed back in or it may result in venous stasis, ulceration of the mucosa and even gangrene. The sooner attempts to reduce the prolapsed rectum are made, the easier it is to do it. In children it is done as follows: the child is placed in a prone position both legs and the pelvis raised; after this the prolapsed part of the rectum is coated with oil or vaseline, covered with gauze and reduction of the rectum begins from its central part. After the central part of the rectum has been pushed in it is easier to push in its external parts.

In adults the prolapsed rectum is reduced while the patients are in an elbow-knee position, the rest of the procedure being the same as in children.

Surgical treatment consists in suturing the rectum to the abdominal wall (colopexy) or surgical strengthening of the pelvic floor.

The preparation for the operation and the postoperative management of the patients are the same as in operations for hemorrhoids. It is necessary carefully to shave the pubic and anal regions and, in plastic operations with a fascia lata, also the surface of the thigh. The preparation of the intestines and the preoperative and postoperative diet are the same as for operations on hemorrhoids.

Prophylaxis consists in proper treatment of gastrointestinal diseases, especially colitis and dysentery, general roborant treatment of weak patients, all-round physical development for persons engaged in physical labour and replacement of manual weight lifting with mechanical methods of lifting weights.

INJURIES AND DISEASES OF THE LIVER AND THE BILE DUCTS

Ruptures of the Liver. Ruptures of the upper surface of the liver, mainly of the right lobe, are observed in 59 per cent of all cases of closed injuries to the abdominal cavity.

The clinical picture is one of an internal hemorrhage, namely, shock, at first deceleration and then increasing acceleration of the pulse, pallor, cold sweat, vertigo, weakness and syncopic state, forced sitting position, then dullness in the lower parts of the abdominal cavity and signs of peritoneal irritation.

The *treatment* consists in an immediate operation with suturing the rupture. Mortality depends on the period of intervention.

Liver Injuries. Liver injuries are rarely observed apparently because most of the people sustaining them soon die. Some liver injuries are regarded as injuries of the thoracic cavity.

Injuries to the liver are *diagnosed* by the direction of the wound canal, the characteristic picture of internal hemorrhage, dullness in the sloping parts of the abdominal cavity, tension of the abdominal wall, changes in hepatic dullness, bile effusion from the wound, pains in the region of the liver, the sign of peritoneal irritation, and forced half-sitting or sitting position. However, not one of the signs alone offers reliable data for diagnosis. The difficulty of diagnosis is increased in combined injuries. Injuries to the liver may sometimes be diagnosed during the initial examination of the patient and the primary treatment of the wound. However, this is often impossible. For this reason, if there is the slightest doubt and injury to the liver is suspected, an urgent operation—incision and examination of the abdominal cavity—must be performed.

Abscesses of the Liver (abscessus hepatis). Abscesses of the liver most frequently develop as a complication of appendicitis or some other purulent process in the abdominal cavity, amebic dysentery and traumas of the liver. Single and multiple abscesses are distinguished.

The signs are not infrequently vague. They include indisposition, pallor, yellowish coloration of the integuments, hectic and sometimes normal temperature, leukocytosis, pains in the

region of the liver (referred to the shoulder), elevated diaphragm revealed by roentgenoscopy, and sometimes exudate in the pleura.

Treatment in cases of dysenteric abscesses may be conservative

Fig. 290. Metastatic cancer of the liver

(emetine 0.02-0.03 per day) or surgical—opening after isolation of the abdominal cavity by suturing the diaphragm or the peri-

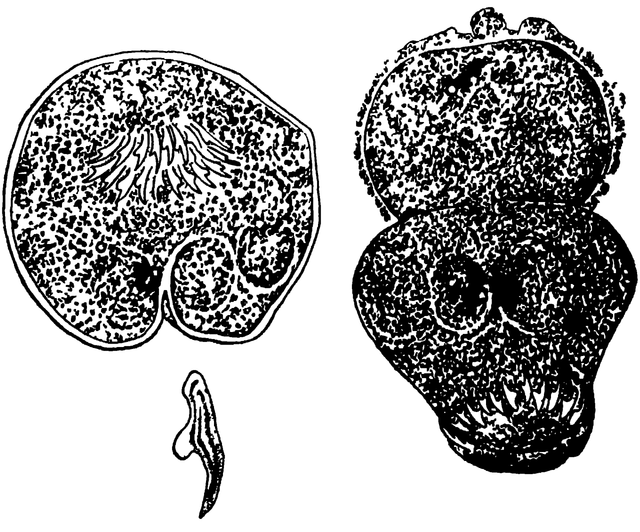
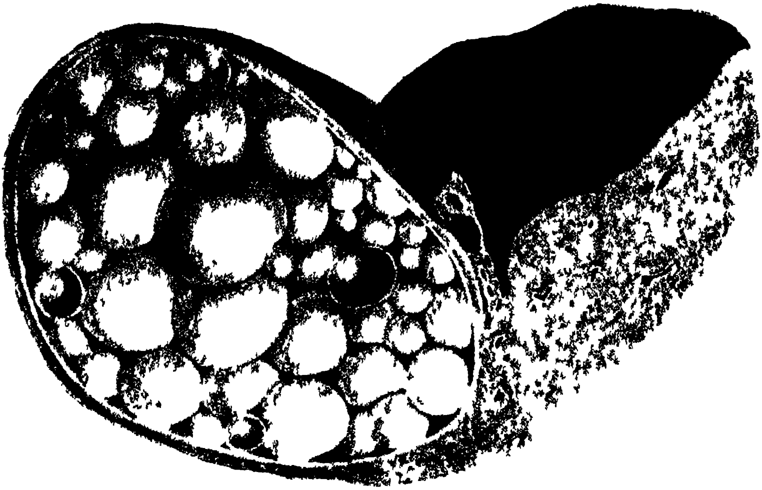


Fig. 291. Scolex and hooks of the Echinococcus

toneum. Mortality ranges, according to different authors, from 7 to 40 per cent.

Tumours of the Liver. Echinococcus cysts, cavernous angiomas and other tumours serve as the basic indications for surgical



Echinococcosis of the liver

Sections through urinary calculi

intervention in the liver. Secondary (metastatic) cancer is most frequently observed in the liver as a result of primary affection of some other abdominal organ (Fig. 290).

The *symptoms* of tumours of the liver are very scant. Tumours produce no functional disorders for a long time. Sometimes the patients have a feeling of heaviness and fullness and sometimes pains. Tumours of the liver are often accidentally discovered during examination of the patients.

Echinococcosis of the Liver. Echinococcosis is infestation of man with the *Echinococcus granulosus* in its hydatid stage, the tapeworm that lives in the intestines of the dog. The Echinococcus infests mainly the liver, forming single or multiple cysts (Table XIII) containing a transparent fluid with floating hooks and scolices of the Echinococcus (Fig. 291). A dense connective-tissue capsule forms around the cyst.

The *symptoms* of infestation of the liver with the Echinococcus are not characteristic and there are hardly any pains. Not infrequently Echinococcosis is diagnosed only during examination of the abdominal cavity or when the cyst becomes so large that the patient begins to feel a heaviness. In cases of infestation of the liver with the Echinococcus there are characteristic changes in the blood in the form of eosinophilia and Casoni's reaction. When Echinococcus cysts suppurate the temperature rises and a feverish state develops.

Prophylaxis consists in carefully burying or burning the Echinococcus cysts of cattle during their slaughter, keeping dogs out of inhabited rooms and preliminary examination of the feces of pet dogs for infestation with the Echinococcus, washing the hands before eating, and consuming only washed vegetables.

This disease *is treated* only surgically. The operation is performed in different manners and ends in excision of the cyst, but most frequently in removal of its contents; however, the contents must be removed very carefully so that the fluid contained in the cyst may not gain entrance into the abdominal cavity, otherwise the latter will be infested with the Echinococcus. The cavity of the cyst is swabbed with a 5 per cent formalin solution to destroy the germs and is tightly sutured or tamponed (especially in cases of purulent echinococcosis).

Care. The preparation of patients for the operation is the same as it is for a laparotomy. The postoperative care varies with the character and scope of the operation. It is most complicated in cases of treatment by the open method. These cases require protracted dressings with tamponing or draining the cavity of the echinococcosis until the connective-tissue capsule becomes disengaged and the wound is covered with granulations. After disengagement of the capsule protracted effusion of bile through the

wound is sometimes observed (the skin must be protected against *irritation!*).

Inflammation of the Gallbladder (cholecystitis). Acute and chronic forms of cholecystitis are distinguished. Women are affected with cholecystitis more often than men.

The inflammatory process in the gallbladder is caused by infection, for the development of which the wall of the bladder offers favourable conditions (narrow passages). Infection gains entrance into the gallbladder either with the blood stream (for example, in typhus) or from the intestines through the bile ducts. Development of infection is particularly favoured by biliary stasis in the gallbladder due to spasm or mechanical difficulties of outflow. Inflammation of the gallbladder is often combined with formation of biliary calculus therein (Fig. 292); in such cases it is very difficult to tell by the picture of the disease whether it is only inflammation of the bladder or it also contains calculus. Calculus forms in most cases of protracted inflammation in the region of the bladder and, contrariwise, the presence of calculus predisposes the gallbladder to inflammation.

Fig. 292. Cholecystitis. Calculus in the neck of the bladder

The *pathoanatomical* changes in the gallbladder during the acute stage consist in a catarrhal inflammation of the mucosa, but sometimes a phlegmonous or even gangrenous process involving the entire thickness of the gallbladder wall takes place. In chronic cases there are sclerotic changes in the gallbladder wall, adhesions to the surrounding organs and not infrequently constriction and even obliteration of its duct. The presence or absence of calculus in the gallbladder is of no particular importance for deciding the question of operation; in cases of protracted and continuously recurring inflammation of the gallbladder the latter is excised even if it has no calculus.

Symptoms. An acute attack of sharp pains in the right hypochondrium referring to the right scapula and arm is characteris-

tic of cholecystitis. The pains are accompanied by vomiting and pyrexia. Examination reveals muscular tension and extreme painfulness in the right hypochondrium, corresponding to the position of the gallbladder. After injection of morphine the intense pains cease, but a dull pain remains, especially on contact with the region of the bladder. Attacks of acute cholecystitis usually last several days. Only in cases of a severe phlegmonous process the disease lasts much longer and may become aggravated by an abscess in the region of the gallbladder with the pus breaking through the abdominal wall or into the adjacent organs. Recurrence of acute attacks and painfulness in the region of the gallbladder during the intervals between the attacks are characteristic of chronic cholecystitis. In addition to the attacks of cholecystitis, during such chronic inflammatory process in the bile ducts so-called biliary colic is noted, i. e., transient attacks which are regarded as an expression of spastic contraction of the gallbladder and the bile ducts. Biliary colic is often a sign of the presence of calculus in the gallbladder, but may also be observed in inflammatory processes in the bile ducts, which render the normal flow of the bile difficult and hamper its normal outflow because of a swelling of the mucosa.

Very intense pains in the right hypochondrium, referring to the right shoulder and scapula, are characteristic of biliary colic. During the colic the patient is usually very restless and tries to alleviate his suffering by changing the position of his body. Pallor, an expression of suffering on the face and a rapid pulse are observed. Examination reveals painfulness in the region of the gallbladder.

Characteristic of colic is the fact that it does not last long and usually passes soon after a subcutaneous administration of morphine and pantopon, but sometimes may recur very frequently, even several times a day.

Prophylaxis. To prevent acute cholecystitis and aggravations of the process, it is necessary to keep for a long time mainly to a vegetable and dairy diet completely excluding foodstuffs rich in cholesterol (eggs, brains, etc.) and spices (mustard, pepper), and take measures against constipation and other gastrointestinal disturbances

Complications. Chronic cholecystitis sometimes involves complete obstruction of the bladder duct, which in the presence of an inflammatory process in the gallbladder leads to a discharge of a mucous fluid into its lumen (hydrops of the gallbladder). The disease is characterised by appearance of a swelling, sometimes of considerable size, in the region of the gallbladder.

Another and still graver complication of cholelithiasis is *obstruction of the common bile duct* (ductus choledochus) by a calculus (Fig. 293). In addition to the colicky pains, obstruction

of the common bile duct is accompanied by sudden intensive yellow pigmentation of the skin (jaundice). Colourless (clayey in appearance), whitish feces are simultaneously observed.

Protracted obstruction of the bile duct causes severe disorders of the hepatic function and degenerative changes in the hepatic cells, and is dangerous to life.

Treatment. Acute attacks of cholecystitis are subject to conservative or surgical treatment

During acute attacks operations are resorted to less frequently than in acute appendicitis, because in these cases, unlike acute appendicitis, there is less danger of complication by peritonitis. In most cases acute attacks terminate within several days, although they may become aggravated by jaundice.

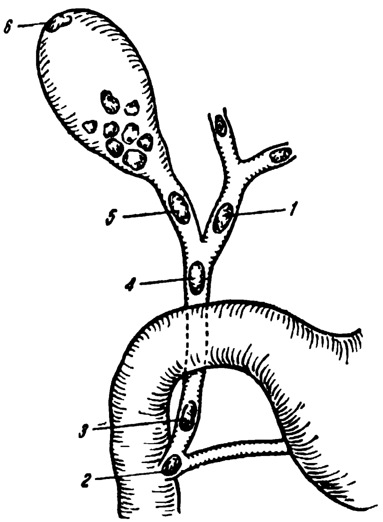


Fig. 293. Diagram showing location of calculi in the bile ducts

1—in hepatic duct; 2—in ampulla of Vatter; 3 and 4—in common bile duct, 5—in cystic duct, 6—in gallbladder

The conservative measures include heat applied to the region of the gallbladder, confinement to bed, subcutaneous administration of morphine or pantopon, and antibiotics. During acute attacks of cholecystitis and during the first days following the attacks the patient must keep to a diet consisting mainly of vegetable and carbohydrate foods. It is particularly necessary to avoid rich and seasoned dishes and meat.

Surgical treatment is indicated in gangrenous, phlegmonous and perforating cholecystitis.

Chronic cholecystitis is also treated conservatively. Good results are produced by keeping for a long time to a special diet and drinking mineral waters (Yessentuki).

Internal irrigation of the bile ducts is one of the very successfully employed therapeutic measures, which is at the same time of diagnostic value. The irrigation is performed as follows: in the morning the patient is placed (on an empty stomach) on his right side without a pillow, but with a bolster under the hypochondrium, and a thin tube is slowly introduced into the stomach. The probe must be swallowed particularly slowly when it reaches the 400-cm mark; if it is introduced rapidly, it is likely to coil in the stomach and the cannula will not pass through the pylorus. As soon as the probe reaches a depth of 50 cm, the fluid begins to be carefully pumped out with a syringe, its colour and

reaction being tested by litmus paper. An alkaline reaction (reddening of the blue litmus paper) shows that the tube has gained entrance into the duodenum. In this case the end of the tube is inserted in a test tube and the liquid will be discharged spontaneously.

When light, golden-green bile begins to be discharged from the bile ducts (portion A), 30.0 of a 25 per cent magnesium sulfate solution is administered through the tube (into the duodenum). Owing to a reflex contraction of the gallbladder, dark-olive, heavier and green cystic bile (portion B) begins to be discharged. Finally, within several minutes light golden bile from the bile ducts of the liver (portion C) appears again.

The different portions are collected for analysis separately. The patency of the gallbladder duct and the presence of an inflammatory process in the gallbladder are judged by the presence or absence of portion B and by discovery of large numbers of leukocytes during microscopic examination. In addition to its diagnostic value, the probing is also of therapeutic importance, because during the reflex of the gallbladder the latter frees itself of the congested bile.

Incases which stubbornly resist treatment and in which there are frequent attacks surgical treatment of chronic cholecystitis is indicated, although during the intervals between the attacks of biliary colic the patients may not have any signs of the disease.

Inflammation of the gallbladder and bile ducts may spread to the intrahepatic bile ducts (cholangitis).

Of the other complications necessitating surgical intervention mention must be made of obstruction and constriction of the cystic duct with formation of hydrops of the gallbladder or accumulation of pus in the gallbladder (*empyema of the gallbladder*).

The *preparation of patients for an operation* for cholecystitis is the same as that for any operation in the abdominal cavity (bath, shaving, enema on the eve of the operation). In cases of protracted disease of the gallbladder, especially in the presence of jaundice, it is necessary to analyse the blood for coagulation and administer special treatment aimed at enhancing coagulation (administration of calcium, horse serum and vikasol).

The *operation is performed* under local or general anesthesia. The main parts of the operation are: incision of the abdominal wall in the right hypochondrium, isolation of the gallbladder and its removal after ligation of the duct (cholecystectomy). Tampons are inserted in the region of the ligated duct and in the place formerly occupied by the gallbladder (matrix of the bladder), and the wound is partly sutured. The tampons are removed after the sixth day; subsequently discharge of bile through the wound is sometimes observed.

The *postoperative management* is the same as it is after a laparotomy. The diet is the same as it is during an acute attack of cholecystitis (without fats).

In cases of saturation of the dressing with bile it is necessary to add dressing material and subsequently frequently to change the dressings, protecting the skin with ointments or pastes against irritation with bile.

In cases of inflammatory obstruction of the common bile duct a T-shaped drainage tube is introduced; one end of the tube is brought out to the exterior through the wound together with the tampon; the bile is at first drained through the drainage tube into a special vessel and the amount of discharged bile is measured daily. Within a few days, if the bile is light and the patient's condition is satisfactory, the drainage tube is clamped so that the bile may not flow outside but may be secreted into the intestines. A biliary fistula sometimes remains after removal of the drainage tube during the second or third week.

It is necessary carefully to watch the patient's general condition because, in addition to cardiac complications, an internal hemorrhage is possible. It is also necessary to watch the dressing which may become soaked in bile (in which case dressing material should be added) or in blood owing to parenchymatous hemorrhages to which jaundice patients are particularly inclined. In such cases aid consists mainly in measures favouring better blood coagulation.

The possible complications include, in the first place, effusion of bile, sometimes in very large amounts, which extremely exhausts the patients. Especially copious effusion of bile into the wound and the formation of a biliary fistula are observed after removal of the drainage tube inserted in the bile duct. The dressing becomes saturated with bile the most after removal of the drainage tube, i. e., usually between the 15th and 20th days after the operation. To protect the skin against irritation with bile, the skin surrounding the fistula must be more frequently coated with pastes and dressed, and the wound must be tamponed. If the biliary fistula does not heal, it must be closed up surgically.

The other complications are the same as in most laparotomies, namely, pulmonary complications and peritonitis.

INJURIES AND DISEASES OF THE SPLEEN AND PANCREAS

Of the diseases of other abdominal organs whose surgery has certain peculiarities, mention should be made of the diseases of the spleen. The main operation on the spleen is its surgical removal in cases of its injury, tumours, enlargement (splenomegaly), infestation with the Echinococcus, etc.; most frequently, however,

the operation is performed for the purpose of influencing the system of hemopoietic organs, especially to impede decomposition of the red blood cells in cases of hemolytic jaundice, and a number of other blood diseases. In some cases gastrointestinal hemorrhages are observed. The preparation of the patients for an operation, if it is not an emergency operation, is the same as it is for any laparotomy. The instruments are also the usual laparotomy instruments. In addition, various abdominal speculums and strong hemostatic clamps for the hilus of the spleen are prepared. The postoperative care is the same as usual. In such operations everything necessary for a blood transfusion should be kept in readiness.

Lastly, surgical intervention is sometimes resorted to in diseases of the pancreas (its inflammations, tumours and cysts).

Acute pancreatitis is a grave disease which, as a rule, requires an urgent operation. After violation of dietetic rules, especially in stout patients, the disease begins with sharp, frequently engirding pains in the back and epigastric region. The general condition rapidly grows worse. Intoxication increases, the pulse accelerates, abdominal distention and tension of the abdominal wall appear.

The urine is found to contain more diastase. Subsequently peritonitis develops and is not infrequently followed by death.

The operation consists in administration of novocain and antibiotics into the tissues surrounding the gland, opening the capsule of the gland and tamponade. The preparation of the patients for the operation and the postoperative care are the same as in laparotomies.

Another disease of the pancreas in which surgical treatment is administered is cancer of the pancreas. The cancer is most frequently located in the head of the gland and because of compression of the common bile duct produces a picture of mechanical (obturation) jaundice. The patients are subject to surgical treatment, namely, palliative operations of switching the bile into the intestines, while in some cases it is possible to perform the very difficult operation of removing the head of the pancreas (duodenopancreatectomy).

Since the condition of these patients is very grave (danger of hemorrhages, insufficiency of hepatic function) and the operation is very difficult, the subsequent management of the patients is complex and requires special skills.

INJURIES AND DISEASES OF THE UROGENITAL ORGANS

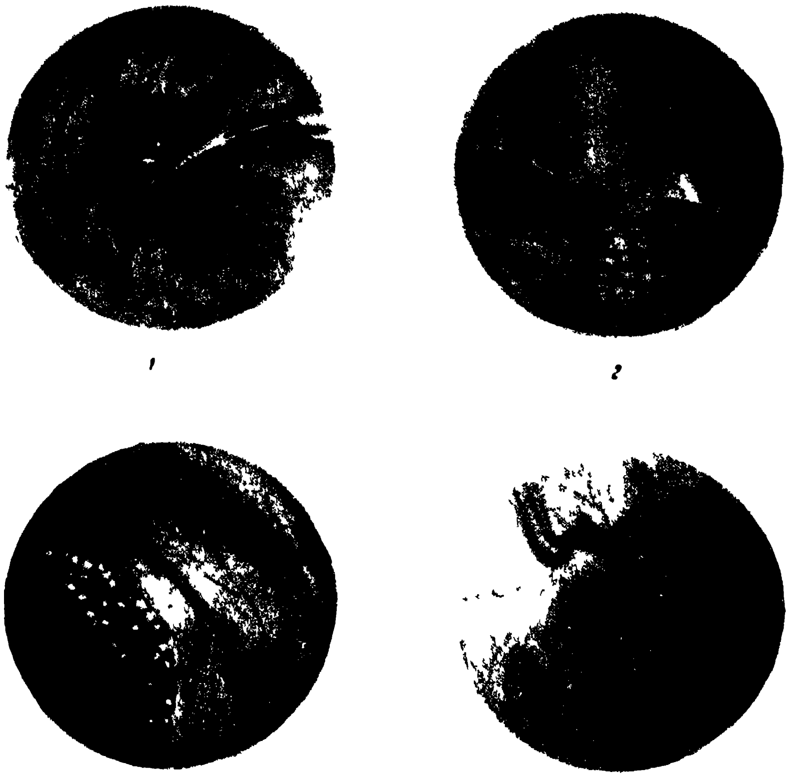
General Diagnosis of Urogenital Diseases. The branch of medicine dealing with the urogenital organs is known as urology. It includes surgery of the kidneys, ureters and urinary bladder, the urethra and genitalia.

Renal diseases are characterised by so-called dysuric phenomena, i. e., difficult, painful and frequent urination, presence of blood and pus in the urine, etc.; however, these diseases can be diagnosed more precisely only after special roentgen and laboratory examinations.

The preliminary examination of renal efficiency is called a *functional examination of the kidneys.* The examination is conducted variously. The efficiency of the kidneys can be judged by the amount and specific gravity of the urine, especially if the patient is given definite amounts of liquid before the examination. These examinations are called *concentration tests.* In the morning the patient is given to drink 1,500 ml of liquid on an empty stomach in the course of one hour, following which the urine is collected in definite portions, the patient being asked to urinate every hour. Each portion of the urine is measured and its specific gravity is determined. The examination continues for eleven hours, during which time the patient receives no liquid. On the following day the patient receives no liquid since the morning and is given only dry food, while his urine is collected in separate portions every hour and is examined. A normal, retarded, poor, very poor and elevated types of concentration and dilution are distinguished.

To examine the work of each kidney separately chromocystoscopy is used. The patient's urinary bladder is irrigated through a catheter with a weak solution of boric acid until an absolutely transparent fluid is discharged. Following this the urinary bladder is filled with the same solution until the patient feels a weak urge to urinate. Then the catheter is removed and a cystoscope is inserted in the urinary bladder. The cystoscope looks like a metal catheter, but has a small electric bulb at the end, and a system of speculums and glass inside. Through the cystoscope it is possi-

TABLE XIV



Cystoscopy

1— Introduction of a ureteral catheter, 2— Discharge of pus from the ureter, 3— Vesical calculus, 4— Vesical papilloma

ble to examine the walls of the urinary bladder and its contents, to see the orifices of the ureters and their ejection of urine (Table XIV).

Examination of the urinary bladder by means of a cystoscope is called cystoscopy. If a special blue dye (4-5 ml of a 0.3-0.4 per cent indigo carmine solution) is injected into the patient's blood, the dye, as a foreign substance, will begin to be excreted in the urine and within 3-5 minutes it will be possible to see how jets of urine coloured blue begin to be spurted out of the orifices of the ureters. By the time the dye begins to be excreted it is possible to judge how well the kidney works. Such an examination is called chromocystoscopy. Lastly, it is possible to introduce, by means of a syringe, a 25 per cent solution of sodium bromide through ureteral catheters into the renal pelves in order to obtain the shape and position of the ureters and renal pelves in the subsequent roentgen picture. This method of examination is called *pyelography*. A simpler method of pyelography consists in making roentgen pictures (roentgenography) after administration of 50 ml of a 40 per cent sergosin solution into the ulnar vein, in which case a clear shadow of the renal pelves and the ureters is produced in the picture.

Before roentgenography the patient's intestines must necessarily be cleansed with an enema, and one day before the examination milk must be excluded from his diet. Lastly, a correct diagnosis requires repeated examinations of the urine, sometimes bacteriological (for example, for tubercle bacilli).

INJURIES AND DISEASES OF THE KIDNEYS AND URETERS

In injuries in the lumbar region rupture of a kidney may occur. Injuries to the kidneys are also observed during open traumas in the lumbar region, especially in cases of gunshot wounds.

The *symptoms* of renal injury are not always characteristic. Nothing but painfulness and sometimes a swelling is observed locally in the renal region. The most characteristic sign of renal injury is blood in the urine following trauma in the region of the kidneys.

Treatment. Since injury to a kidney threatens infiltration of the surrounding tissues with urine and grave infectious complications, and, what is most important, is accompanied by profuse internal bleeding, it necessitates an operation. If a kidney is crushed, it is removed. The operation is performed urgently for which reason the intestines cannot be prepared and the patient cannot be given a bath.

After removal of the kidney the patient is prescribed a strictly dairy diet; the daily urine is collected and measured. Since the wound is tamponed after the operation and the dressing may

become soaked in blood, an oilcloth is placed under the patient and a massive dressing is applied.

Inflammatory diseases. Although inflammation of the *renal pelvis* (pyelitis) does not require surgical treatment, the manipulations, both diagnostic (pyelography and catheterisation of the ureters) and therapeutic (irrigation of the pelves) warrant considering this disease a surgical disease. Infection may gain entrance into the pelvis through the blood or may ascend from the urinary bladder along the ureters.

The main *symptoms* are chills and pyrexia, pains in the lumbar region and changes in the urine (high leukocyte count).

The *treatment* consists in confinement to bed, dairy diet, administration of salol and urotropin per os, penicillin intramuscularly and urotropin intravenously, catheterisation of the ureters and irrigation of the pelvis.

In *paranephritis* (inflammation of the perirenal tissue) the infection may be transmitted from the pelves, but it is often of an embolic character without visible affection of the kidneys. The disease develops slowly, the signs being at first indefinite: feverish condition, pains in the lumbar region, and flexion of the lower extremity in the hip joint. Examination of the urine reveals no pathological deviations.

Clearer symptoms appear when an abscess has formed and is approaching the external integuments. The treatment consists in opening the abscess with an incision in the lumbar region below the 12th rib.

Renal diseases. One of the most frequent diseases of the kidneys subject to surgical treatment is *renal calculus* (kidney stones) characterised by appearance in the renal pelvis, kidneys and ureters of solid concretions and salts deposited by the urine (Table XIII). A concretion which is located in the pelvis or has descended into the ureter hinders passage of the urine and on growing larger compresses the renal tissue and causes its atrophy (Fig. 294), breaks the vessels (hemorrhage) and fosters development of an inflammatory process in the pelvis (pyelitis).

One of the main *symptoms* of the disease is renal colic, for which reason the patient applies to the physician. In colic the pains are localised in the lumbar region, are referred to the inguinal region, the glans penis and testes, the thigh and the labia majora. The pains are usually very intense. The temperature is most frequently elevated. If the attack continues for some time, paresis of the intestines with meteorism and abdominal distention develops. The attacks of colic are accompanied by a desire to urinate, with blood found in the urine.

A final diagnosis may be made by means of roentgenographic examination because the larger concretions produce shadows in the picture.

First aid during attacks of renal colic consists in a warm bath and administration of narcotics (morphine, pantopon and belladonna).

In the *treatment* of renal calculus attempts are made to increase the amount of urine by giving the patient a lot to drink, especially mineral waters, and by prescribing a special diet, depending on the composition of the concretions. Thus, it is possible to remove the smaller concretions and salts and prevent the remaining ones from enlarging. In a number of cases this disease requires an operation, for example, in cases in which the condition of the pelvis and kidney is aggravated by infection, retention of the urine, continuous pains (which incapacitate the patient), descent of a concretion into the ureter, and profuse hemorrhages.

Of the other renal diseases subject to surgical treatment mention must also be made of the difficulties of excretion of the urine from the kidneys owing to *obstruction of a ureter with a concretion*, *ureteral constriction* or *kink*.

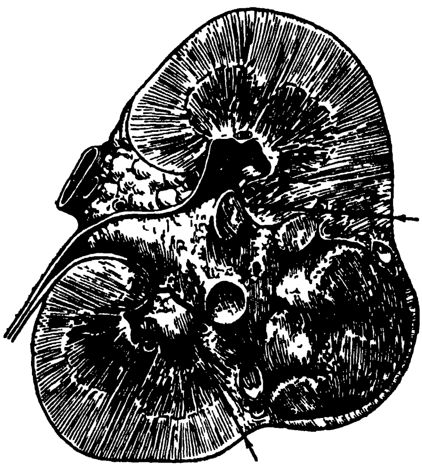


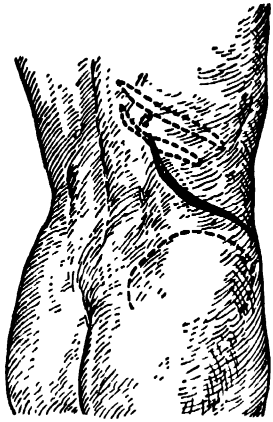
Fig. 294. Atrophy of renal tissue because of calculus in the renal pelvis and kidney

The urine retained in the pelvis distends the latter and compresses the renal tissue; this gradually leads to atrophy of renal tissue and in place of the kidney there is, finally, only a bag filled with fluid, and walls consisting of remains of renal tissue. This disease is called *hydronephrosis.* The patient complains of heaviness and pains in the region of the kidney and in the abdominal cavity; palpation reveals a swelling. A kidney may become similarly distended as a result of accumulation of pus in the renal pelvis, the pus being from time to time excreted in the urine into the urinary bladder. This disease is known as *pyonephrosis*, and its signs, in addition to those common with hydronephrosis, are pyrexia, pain on examination in the renal region and pus in the urine.

Of the other renal diseases requiring surgical treatment mention should be made of *tuberculosis of the kidneys.*

This disease develops as a result of penetration of tubercle bacilli with the blood stream into the kidneys from some tuberculous focus in the organism. Only one kidney is most frequently

affected at first. A dull, sometimes colicky, pain appears in the region of the kidney, the patient has a frequent desire to urinate, and the urine contains pus and blood. During this disease the temperature is normal or subnormal, and the disease becomes chronic and not infrequently results in death.

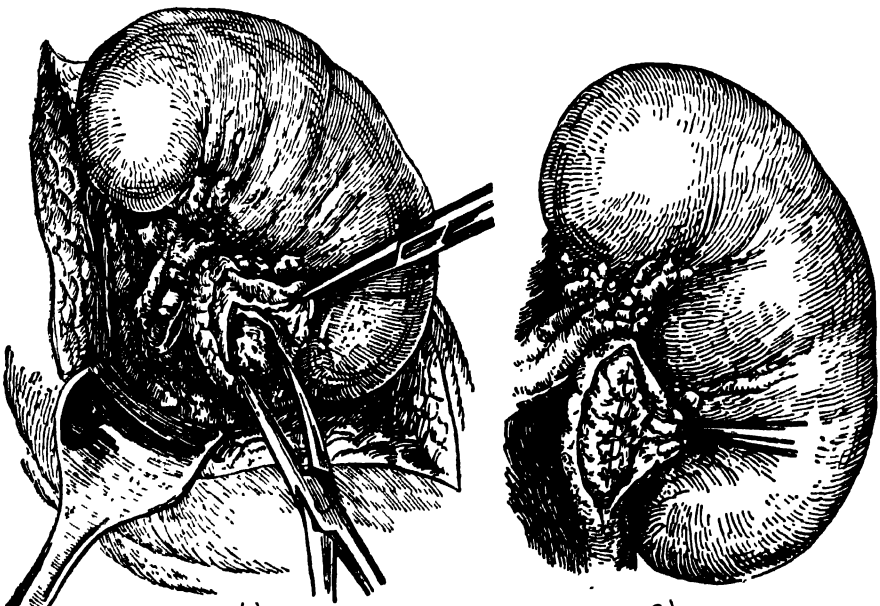


a)

The patients must be given a special examination (urinalysis, a tubercle bacilli culture, chromocystoscopy, pyelography and catheterisation of the ureters).

The treatment is specifically conservative antituberculous and, when the process is unilateral, also surgical.

The management of patients varies with the gravity of the condition and the complexity of the operation. During the postoperative period it is necessary particularly carefully to watch the patient's general condition (danger of uremia), collect and accurately measure the urine, and administer antituberculous treatment.



b) c)

Fig. 295. Pyelotomy

a—incision; b—removal of calculus from the renal pelvis; c—suturing the pelvis

The kidneys may have benign as well as malignant *tumours.* The tumours originate from the kidney and pelvis, as well as the adrenals. Hypernephroma is the most frequently observed malignant tumour. The symptoms of renal tumours are blood in the urine and pains.

Renal operations. The most convenient surgical approach to a kidney is from behind, from the lumbar region below the 12th rib (Fig. 295, *a*). Of the basic operations we shall mention only the operations of removing calculus by *incision of the pelvis or kidney* (Fig. 295, *b*, *c*). After operations the wounds are usually tamponed and incompletely sutured. During the postoperative period, in addition to caring for the skin and watching the heart, special attention must be devoted to the patient's urination; all the urine is collected and measured, its daily amount is noted and it is systematically examined for blood. After renal operations a vegetable and dairy diet excluding all meat, broths, seasoned or acid food is prescribed and the patients must be given a lot to drink.

Complications. Of the complications following renal operations, besides those which are possible after any operation, mention must be made of discharge of blood with the urine. Little blood in the urine is often observed after operations on the kidneys, but a large amount of blood, especially bright-red, must attract the attention of the medical personnel. The presence of blood in the urine must immediately be reported to the physician. Ice is temporarily applied locally, horse serum is administered subcutaneously and calcium chloride intravenously. Another frequent complication after renal operations is intoxication with the metabolites not excreted with the urine (uremia). This is a very grave complication which sometimes rapidly leads to death. Uremia is manifested by insufficient urine or even its complete absence, appearance of intense headaches, vomiting, unconsciousness, convulsions, a slow and tense pulse. Bloodletting, hot packs, camphor subcutaneously and hot water bottles in the region of the remaining kidney may relieve the patient's condition.

INJURIES AND DISEASES OF THE URINARY BLADDER AND THE MALE SEXUAL ORGANS

Injury to the Urinary Bladder and the Urethra. A number of closed injuries (fractures of the pelvis), blows at the lower part of the abdomen and open injuries (wounds) to this area may affect the urinary bladder.

Injury to the urinary bladder greatly complicates the basic affection because, as a result of penetration of urine through the injured walls of the urinary bladder of the urethra into the sur-

rounding tissues, the latter are infiltrated with urine and a phlegmonous process develops, while injury to the peritoneum results in peritonitis.

The following are *symptoms* of injury to the urinary bladder: great urge to urinate and small amounts of urine usually voided with blood; during catheterisation the urinary bladder proves to be empty or contains a small amount of blood. If the urine gains entrance into the abdominal cavity, the abdominal wall is tense and sensitive to pressure.

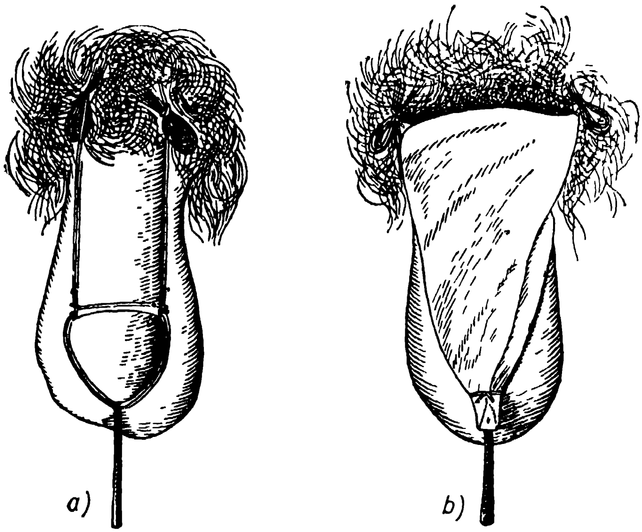


Fig. 296. Fastening the catheter
a—with a thread, *b*—with a gauze napkin

The *treatment* is exclusively surgical and consists in an abdominal wall incision over the pubes, baring the urinary bladder and suturing its wound.

A permanent catheter is introduced into the urinary bladder through the urethra. The preparation for the operation is the same as for urgent intervention (shaving the pubes and perineum with no bath and no evacuation of the bowels).

During the postoperative period either a permanent catheter or frequent catheterisation is used and the administration of liquids is limited (at any rate accumulation of urine in the urinary bladder must be avoided).

The *preparation* of the patient for the operation on the urinary bladder consists in alleviating the inflammatory phenomena by protracted irrigations of the bladder with disinfectants. Before the very operation, if the bladder is not injured, it is irrigated and filled through the catheter with a disinfecting solution or

air. This is done to facilitate the operation, since a distended bladder rises over the pubes, detaches the peritoneum and becomes more easily accessible.

Care. After operation on the urinary bladder a soft rubber catheter is often inserted in the urethra for several days. To prevent it from falling out, it is fastened with plaster or tied to the glans penis (Fig. 296). In some cases the wound in the urinary bladder is closed up only partly and a heavy drainage tube (urinary fistula) is inserted in the bladder. A similar urinary fistula may also develop in cases in which the wound was sutured but the stitches have parted and urine begins to trickle out through the wound. In cases of urinary fistulas it is necessary to irrigate the bladder, systematically wash the skin with warm non-irritating solutions and protect the skin against irritation (coat it with pastes or dust it with powders).

Bleeding from the urinary bladder is not an infrequent complication of operations on it. During operations on tumours and, especially, after removal of the prostate the urine usually contains a considerable amount of blood, whose presence, particularly if it is bright-red, requires hemostatic measures. In addition to the general measures aimed at enhancing coagulation (horse serum, calcium chloride, etc.), the gallbladder is irrigated with warm disinfecting solutions.

Vesical Calculus. Vesical calculus causes sudden retention of the urine. The urine contains blood and sometimes small concretions. A final diagnosis may be made by probing the urinary bladder cavity with a metal catheter, by means of cystoscopy or a roentgen examination. Before roentgenography it is necessary to evacuate the bowels by means of laxatives so that the intestinal masses and the gases therein may not interfere with the production of a good picture. The concretions are removed from the urinary bladder either surgically by opening the urinary bladder through the abdominal wall above the pubes (epicystotomy) or are crushed by a special instrument (stone crusher) introduced into the urinary bladder through the urethra, after which the small fragments are washed out by means of a special balloon.

Hypertrophy of the Prostate. Hypertrophy of the prostate implies a tumorous growth of its muscular, glandular and connective tissue. The causes of this affection are unknown. Since the gland encompasses the neck of the urinary bladder and the beginning of the urethra, when it enlarges, it pushes into the lower anterior wall of the urinary bladder and actually extends into the cavity of the urinary bladder. This disease develops in old age and produces a picture of constriction of the cervix of the bladder with subsequent urinary difficulties and frequent inflammations of the bladder. In such cases the wall of the urinary bladder becomes hypertrophied and the muscle bundles form cross-bars. With great-

er subsequent urinary difficulties the bladder becomes distended, the urine is retained in the kidneys and pelves, and poisons the organism with substances that are normally voided with the urine.

In cases of retention of the urine catheterisation with a soft catheter is administered. If the soft catheter cannot gain entrance, the catheterisation is performed by a physician with a semi-rigid or rigid catheter (Fig. 297). If catheterisation is impossible, the urinary bladder is punctured above the pubes or a urinary fistula is established and the hypertrophied prostate is subsequently removed surgically.

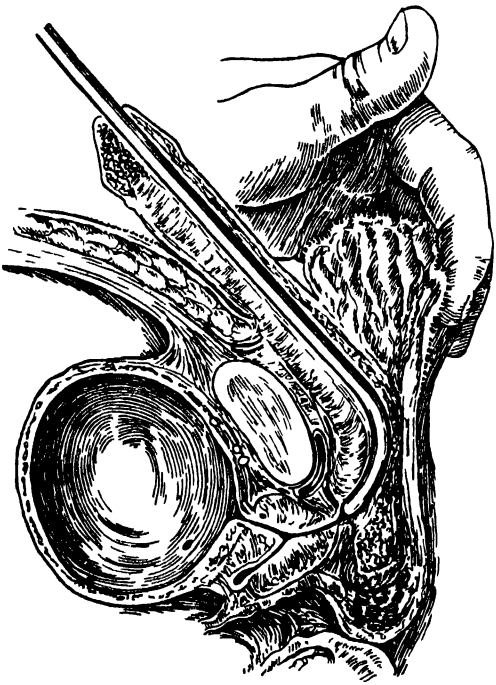


Fig. 297. Catheterisation with a rigid catheter

Stricture of the Urethra The causes of urethral stricture in men are most frequently a chronic gonorrheal process and cicatrices following injury to the urethra. Constriction may lead to almost a complete obstruction of the urethra. Above the site of constriction the inflammatory process produces urinary phlegmons with formation of fistulas Clinically the constriction is manifested in a decreased urinary stream and a necessity greatly to strain during urination. In extreme cases of constriction the urine is discharged only in small amounts despite the overfilled urinary bladder.

The *treatment* of strictures consists in protracted and persistent bouginage, and only in some cases in surgical intervention.

Foreign Bodies in the Urinary Tract. In addition to the foreign bodies which gain entrance into the urinary tract in open injuries (bullets, shell splinters), stones from the kidneys not infrequently descend into it through the ureters and from the urinary bladder through the urethra. Lastly, foreign bodies may also be introduced into the urinary passages through the urethral orifice, for example fragments of catheters and bougies. The picture of the disease depends on the degree of irritation of the urethral walls and obstruction of the urethral lumen

by a foreign body, which hinders urination. In such cases there is a burning and excruciating pain during urination, frequent urge to urinate, retention of urine and blood in the urine. First aid in such cases consists in attempts to remove the foreign bodies. The simplest method is to ask the patient to urinate with the terminal orifice of the urethra closed. This causes distention of the urethra and the foreign body moves towards the exit. Then the urethra is opened and the foreign body may come out together with the stream of urine. In cases of failure the patients are referred to a hospital for surgical removal of the foreign bodies.

Hydrocele. Of the diseases of the testes subject to surgical treatment mention must be made of hydrocele.

In hydrocele a fluid accumulates between the membranes of the testis. This accumulation takes place gradually, over a period of months or even years, becomes very large, distends the scrotum and externally resembles a large hernia. Usually hydrocele produces no pain and discomforts the patient only when it is considerably enlarged by interfering with walking and working. It does not disappear spontaneously and after reaching considerable size must be treated surgically.

The operation is performed under local anesthesia.

During the preparation for the operation the patient must be given a bath, and the scrotum and pubes must be shaved.

Tuberculous Epididymitis. Tuberculous affection of the epididymis and the testis is a very frequent disease. The causative agent usually gains entrance with the blood stream from another tuberculous focus or is transmitted from the urogenital organs affected with tuberculosis. Beginning with the epididymis the process spreads to the testis and may pass along the deferent duct to the seminal vesicles and the urinary bladder. The disease begins with induration of the testis and slight painfulness. The induration keeps enlarging, the pains become intense, the infiltrate begins to soften with tissue decomposition and accumulation of pus which breaks through the skin and forms a fistula.

The *treatment* is general, i.e., treatment of tuberculosis, and local—phototherapy and wearing a suspensory; surgical treatment consists in excision of the epididymis together with the deferent duct, and sometimes together with the testis.

Phimosis and Paraphimosis. Of the diseases of the male sexual organ we shall mention only phimosis, i.e., congenital tightness of the foreskin and constriction of the orifice with a frequent adhesion of its internal fold to the glans penis. This frequently observed disease becomes painful because it interferes with free urination. In cases of constriction of the orifice and inability to uncover the glans penis an inflammation often develops in the sac formed by the foreskin about the glans penis. The disease is

subject to surgical treatment. The operation is often performed on ambulant patients and does not require their special preparation.

Retraction and constriction of the foreskin behind the glans penis causes strangulation of the latter (*paraphimosis*). The disease threatens mortification of the lower part of the glans penis; the latter becomes painful and edematous, and cannot be covered with the foreskin; this must urgently be corrected. It is done as follows (Fig. 298): The penis is held with the fingers of the left hand, while the fingers of the right hand compress the glans penis in order to make it smaller; then the glans penis is carefully retracted and covered with the foreskin. If this procedure fails, surgical intervention is required, i.e., dissection of the compressing ring, after which the glans penis is easily invaginated. The subsequent management of such patients is nothing out of the ordinary. The patients are usually allowed to be up and are kept on a general diet.

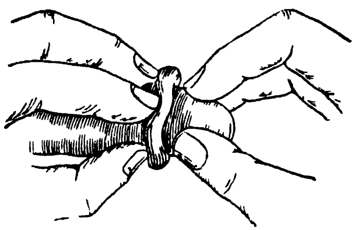


Fig. 298. Paraphimosis

Punctures of the bladder. In cases of urinary retention, in overfilling of the urinary bladder with urine and inability to drain it with a catheter (constriction, rupture of the canal) the bladder is punctured. A syringe and a heavy 10-cm-long needle are used for the puncture. The latter is made directly above the os pubis.

Catheterisation. The instruments for draining the urine (catheters) are made rigid (metal), semi-rigid (silk covered with a special substance) and soft (rubber). Before use, the catheters must be sterilised. Boiling spoils semi-rigid catheters and the latter are therefore immersed in a 1:1000 mercury bichloride solution for 15-20 minutes or are disinfected in special glass jars with tight-fitting plugs. Tablets of formalin are placed on the bottom of the jar, the catheter is suspended inside the jar and the jar is plugged. Such disinfection with formalin vapours must be conducted for at least 24 hours. Rubber catheters are sterilised by boiling for five minutes in a 1 per cent soda solution.

Draining the urine in males by means of hard and semi-rigid catheters requires special skill and must be performed by a physician because improper introduction of the catheter may cause serious complications. It is safer to withdraw the urine through a soft catheter and this can be effected by the intermediate medical personnel. Before catheterisation the hands are carefully washed, the urethral orifice is swabbed with a cotton soaked in a rivanol solution, furacillin, mercuric oxycyanide or lysol, the sterile catheter is coated with sterilised vaseline or castor oil so that it

may penetrate more easily. The catheter is introduced with the aid of a forceps, the upper part of the catheter, as is shown in Fig. 106, being held by the assistant. The catheter introduced into the orifice of the urethra is cautiously, without applying particular force, pushed further in, while the penis is being stretched. The catheter continues to be inserted until urine begins to run from its external orifice into a specially prepared vessel. Sometimes, as a result of a spastic contraction of the sphincter, the catheter stops and fails to enter the bladder; in such cases the catheter must not be pushed in; the nurse must wait until the sphincter relaxes, after which she may carefully continue the introduction of the catheter making sure that the patient breathes evenly and does not tense the abdominal wall. In cases of urethral constriction it is particularly difficult to introduce the catheter and sometimes (the usual catheter) even impossible. In such cases the physician introduces special rigid catheters used for constrictions.

As soon as the urine ceases to be discharged from the catheter, the latter is carefully withdrawn, washed with warm water and used again only after sterilisation.

INJURIES AND DISEASES OF THE SPINE, SPINAL CORD AND PELVIS

Fractures and Dislocations of the Spine. Fractures and dislocations of the spine are unified because they are frequently combined and are therefore very difficult to distinguish.

Symptoms. Injuries to the spine are some of the gravest and most dangerous injuries because of the possible compressions of the spinal cord (Fig. 299). Injuries to the spinal cord lead to paralysis and disturbances in sensitivity of the entire underlying part of the body with absence of defecation, retention of the urine, rapid formation of decubitus, development of sepsis and death.

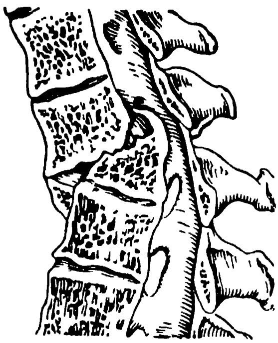


Fig. 299. Compression fracture

Treatment. The results of the injury depend on the degree of injury to the spinal cord at the moment the injury is sustained, as well as during administration of first aid, examination, dressing and transportation of the patient. For this reason, during examination of a patient, putting him to bed, carrying and transporting him, if injury to the spine is suspected, the medical personnel must act as in cases of fracture of the spine, otherwise the spinal cord may be compressed or ruptured even where it did not happen at the time of injury. The patient must lie in a supine or preferably prone position, must not be turned over and must not be forced to sit up. He must be lifted, only when ordered, by experienced stretcher-bearers. Subsequently, the patient must be carried or transported only after something hard (boards, a door, etc.) has first been placed under his back.

When a patient is put to bed, a hard litter (boards, a shield) must also be placed under the mattress so that there is no sagging, which is usually the case with spring mattresses, beds with wire nets, etc.

If the patient is paralysed, or has disorders of sensitivity, urination and defecation, which indicates grave changes in the spinal cord, surgical treatment (to relieve the compression of the cord) is required.

In cases of spinal dislocations the latter are reduced under anesthesia.

Care. Patients with fractures of the spine are subjected to prolonged (sometimes for 3-6 months) traction on an inclined plane. As was already pointed out, the skin of such patients must be watched particularly carefully, because of the danger of formation of bedsores; special attention must also be devoted to their urination—because such patients usually suffer from urinary retention. During catheterisation it is necessary to observe all rules of asepsis (to avoid infecting the urinary tract) and irrigate the bladder with disinfecting solutions. Instead of repeated catheterisation a vesical fistula is made. After cessation of the traction, if the disease runs a favourable course, the patient is put in a corset to support the spine at the point of fracture; the treatment thus takes a total of one and a half or two years. In some cases mobility and sensitivity are recovered only within several months. If the mobility and sensitivity are not recovered, the patients remain invalids for life or most frequently die of bedsores or infection of the urinary tract.

Gunshot Wounds of the Spine and Spinal Cord. These are very grave injuries and are usually accompanied by paralyses, disorders of sensitivity, urinary retention and rectal incontinence. As in closed injuries, such patients must be lifted very carefully; they require the closest attention because they rapidly develop bedsores. The management of the patients is the same as in other injuries to the spinal cord. The main thing is to prevent bedsores and to see that they evacuate the urinary bladder and bowels.

In order completely to immobilise the affected region and relieve the pressure in this region during fractures and inflammatory processes in the spine the patient is put to bed in a supine position for a long period and either traction or a plaster cast are applied, the latter being a special type of removable bandage.

The technique of applying a plaster cast is described in detail below.

Under combat conditions aid in cases of wounds or injuries of the spine consists in most careful transportation and prevention of shock.

Immobilisation of the spine is effected by placing a board covered with a blanket on the stretcher under the patient's back with gauze and cotton rings under the sacrum and the heels. Four plywood or wire splints may also be bandaged to the back and the sides. The wounded are delivered to the shock ward or the operating room or are transported farther. In cases of urinary retention the patients are catheterised.

Immobilisation is effected by means of a plaster cast.

Tuberculosis of the Spine (tuberculous spondylitis). Tuberculosis of the spine is a frequent and at the same time the gravest of all forms of tuberculosis of the bones. It is observed in infants, as well as in adults. Usually the process begins from the body of some one vertebra, in which case, owing to the destruction and resorption of the bony tissue, the body of the vertebra softens and the overlying vertebra sinks under the weight of the body (Fig. 300). As a result a curvature of the spine with a posterior convexity of the curve is formed and a hump develops (kyphosis) (Fig. 301). Usually the affected part fails to grow, which explains the small stature of hunchbacks. Moreover, as the curvature of the thoracic vertebrae develops, the entire thorax becomes deformed, which affects the position, shape and functions of the internal organs. In tuberculosis of the spine abscesses are formed (Fig. 302), i.e., accumulations of pus from the destroyed vertebra which usually descend to some other part of the body; in affections of the cervical part the pus descends to the postpharyngeal space and in affec-

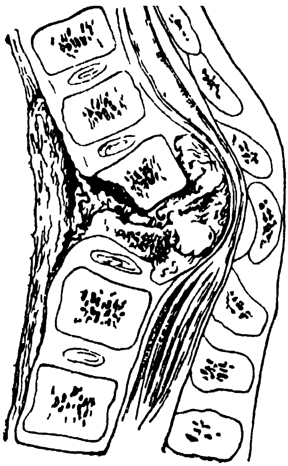


Fig. 300. Tuberculosis of the spine

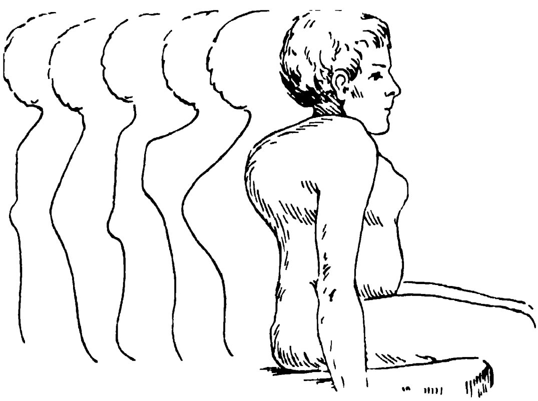


Fig. 301. Diagram of kyphosis of different degrees and shapes

tion of the thoracic and lumbar regions—along the psoas muscle to the femur.

A grave complication of tuberculosis of the spine is compres-

sion of the spinal cord with ensuring paralyses and disorders of the functions of the pelvic organs.

Symptoms. Owing to the deep location of the process, tuberculosis of the spine is at first manifested only in pains in the spine and limitation of its mobility (Fig. 303), then protrusion of one spinous process, painfulness on percussion and pressure develop. Only subsequently is a curvature of the spine in the form of an angle with its apex pointing to the posterior added to these phenomena. Already in early cases of the disease it is possible to discern in roentgen picture a thinning of the body of the vertebra. Tuberculosis of the spine runs a very protracted and stubborn course; relapses of the disease are not infrequent after a lengthy remission. A spontaneous cure comes only after extensive destruction of the spine (large hump). These deformities may be in large measure prevented by proper and timely treatment which consists in a combination of general and local measures.

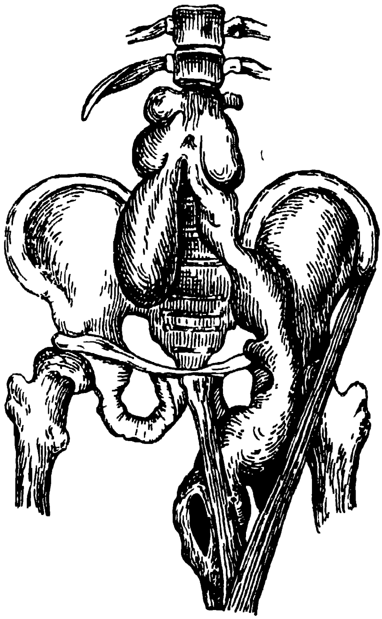


Fig. 302. Pus pockets

The general measures of *treatment* are the same as those mentioned above concerning the treatment of surgical tuberculosis. Local treatment consists in ensuring the patient complete immobilisation of the affected region and of relieving it from pressure. After ascertainment of the diagnosis the patient is confined to bed for a long time. He is placed on his back with hard bolsters under the affected region so as to curve the spine forward. Traction or a plaster cast (bed) are applied for the same purposes. A plaster cast (bed) is used in more acute, incipient or severe cases. With the aid of the cast the body is placed in a position of extension of the affected part (reclination), i. e., the lumbar curve is increased (lordosis) and the thoracic curve is decreased.

To obtain this position of the spine, the patient is placed face downward on a mattress running from the upper part of the chest to the middle of the thighs. Special supports or bolsters are put under the patient's forehead, pelvis and lower part of the thighs or upper part of the shanks. The face is left open for the access of air.

It is more convenient to apply the cast (bed) by using special frames which allow of simultaneous traction of the spine.

Technique of making a plaster cast (bed). The bed may be made from wide plaster bandages, although plaster-impregnated strips 15-20 cm wide and 5-6 layers thick are most frequently used; the length must correspond to the patient's height and differ for the strips running longitudinally, transversely and obliquely.

The longitudinal strips must extend from the top of the head to the middle of the thigh, the transverse—from one nipple across the back to the other nipple, and the oblique strips must run across the back obliquely—from the shoulder joint to the ilium on the opposite side. From six to eight strips of each size are required.

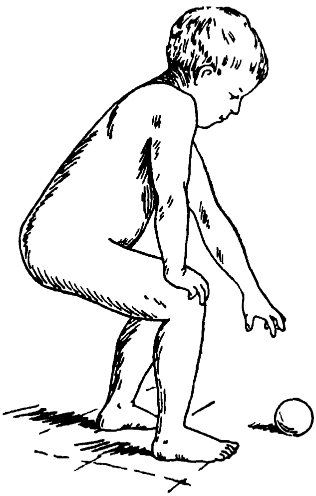


Fig. 303. Examination of the spine. Raising an object from the floor. Protective position

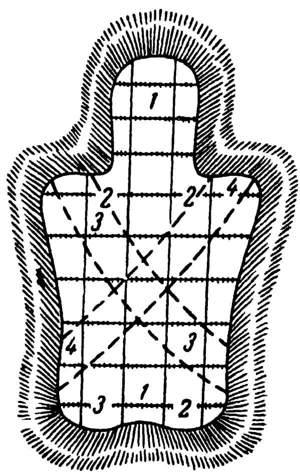


Fig. 304. Course of plaster-impregnated strips of bandage for a plaster bed. Figures show the sequence of applying the strips

The patient is undressed, placed in a recumbent position and covered from the top of the head to the middle of the thighs with a two-layer piece of gauze, the latter being applied evenly, without any creases or folds. The region of the protruding vertebrae (the hump) must be covered with cotton. The cast (bed) is made as follows: the longitudinal strips of gauze are applied first, beginning with the middle strip which extends from the top of the head to the middle of the thighs, and is followed by the lateral strips which run from the corresponding parts of the top of the head to the middle of the thighs. Before application each strip of gauze is moistened and carefully evened and smoothed out;

after application it is again smoothed out and moulded, especially in the region of the occiput, neck and shoulder joints in order that the plaster should correspondingly fill all the recesses and fit all the unevennesses of the posterior and lateral surfaces of the body.

The longitudinal strips of gauze completely cover the posterior and lateral surfaces of the body to the mammillary lines. Application of the longitudinal strips is followed by that of the oblique strips (Fig. 304, *3*, *4*) which extend from the ilia to the

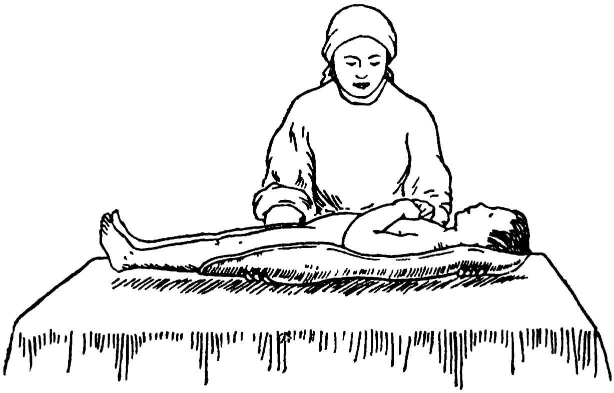


Fig. 305. Finished plaster bed

shoulder joints; the transverse strips are applied last. During application of the bandage, and especially after application of all its layers, it is necessary carefully to mould and smooth out the strips of gauze so that, when the bed is made, it should form a solid homogeneous piece corresponding to the posterior surface of the body. As soon as the plaster has hardened, the bed is carefully removed and placed on a soft litter to dry, the inner surface upward so that it may not change its shape.

The finishing touches are put to the bed when the plaster has somewhat dried. The superfluous parts are cut off and the uneven edges are rounded out; a semi-lunar opening for the bedpan is made in the region of the buttocks, all the unevennesses are coated with thin plaster and the edges are covered with gauze.

The bed takes 5-7 days to dry. Its final appearance is shown in Fig. 305.

Before placing the patient in the bed the latter is lined with a soft cloth. The bed is applied to the patient with the latter in a prone position, following which the patient is turned over together with the bed. In the beginning the patients, especially children, must be bandaged to the bed until they get used to it. As long as the patient is in bed, it is necessary to take particular

care of the skin on his back and see that no bedsores are formed at the points of pressure, especially in the region of the hump, where a window is sometimes made.

To take care of the patient's skin, the patient is turned over together with the bed, the bed is removed and the skin is examined and rubbed down, especially in the regions of the sacrum, occiput, spinous processes and shoulder joints.

As soon as the inflammatory process subsides the bed is replaced with a plaster corset. To correct the curvatures of the spine

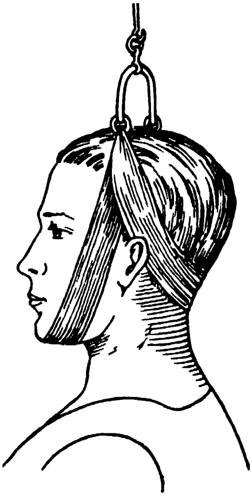


Fig. 306. Glisson's sling

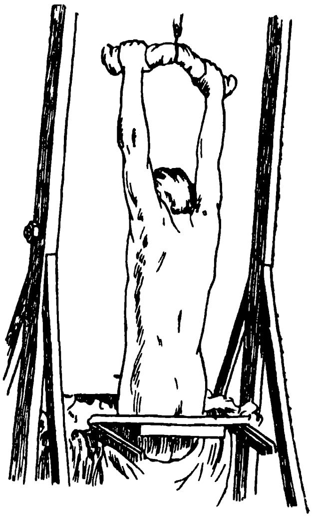


Fig. 307. Hand traction

and reduce the pressure on the affected vertebrae during application of the corset to the spine, temporary traction is applied, for which purpose special apparatus are used. The traction is performed with the patient in a standing position, the pull being applied to the patient's chin and occipital area by means of a special loop (Fig. 306) which can be made of gauze; traction may also be applied to the axillas or arms. To increase the normal concavity of the back and lumbar region (lordosis), the patient is placed in a special stand (Fig. 307).

The stand immobilises the pelvis, and the patient cannot change his position during application of the bandage.

When a bandage with a collar is applied to the cervical part in order to relieve the spine, the normal curve of the neck must be increased and the head must be somewhat retracted.

In order that the corset may prevent the spine from bending and may relieve the affected vertebrae of pressure, the weight of the thorax must be transferred through the corset to the pelvis and

the weight of the head—to the thorax, making the pelvis, costal edge, shoulders and occiput the points of support for the corset.

Application of the corset. The body is wrapped in a thin layer of cotton which is made thicker in the region of the iliac crests and in the back along both sides of the spine.

Still more convenient is a padding made of two layers of tricot with cotton or cotton pads between them corresponding to the larynx, sternum, ribs and protruding spinous processes.

To apply a corset, wide (13-15 cm) plaster-impregnated strips

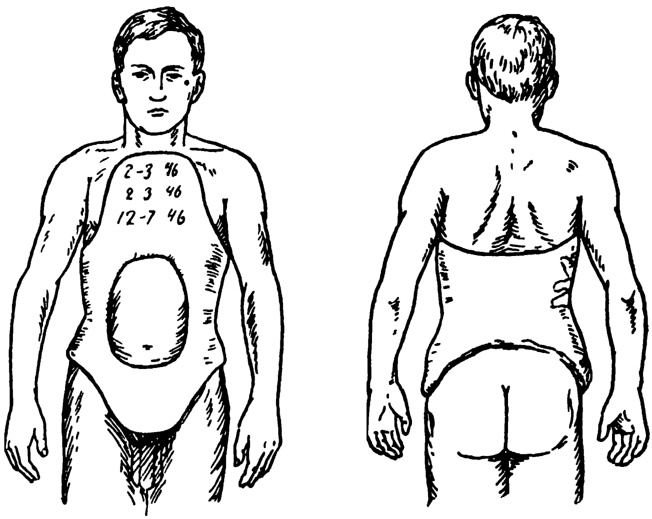


Fig. 308. Plaster corset with window in gastric region

of gauze 4 m long are used. The bandage consists mainly of circular and spiral turns. The corset must embrace the body tightly and evenly, precisely corresponding to all its unevennesses; it must fit these unevennesses well (must be moulded). It must particularly well embrace the points of support, i.e., the crests of the ilia, the regions of the pubes, costal arches and occiput. The corset must generally be carefully moulded after each turn of the bandage.

After application of the corset, before it has hardened, it is finally moulded, the superfluous parts are cut off, and the bandage is evened out and finished. In order that the corset may not discomfort the patient, it is cut at the bottom so that it does not hinder the patient from sitting (in the rear—on the level of the sacrococcygeal junction (Fig. 308), two digits above the greater trochanter on the sides, one digit below the anterior spines of the ilia in front); in addition, a window is cut out in the region of the stomach (Fig. 308) and the corset is cut down in the axillas.

A corset is applied up to the axillas in diseases of the lumbar and lower thoracic vertebrae; in diseases above the 8th thoracic vertebra a corset with a collar is used. The patients wear corsets until the pathological process has terminated; the corsets are changed every few months. A removable plaster corset may also be employed, but it is not particularly convenient, because it is heavy and fragile.

Fractures of the Pelvis. Fractures of the pelvis are very grave

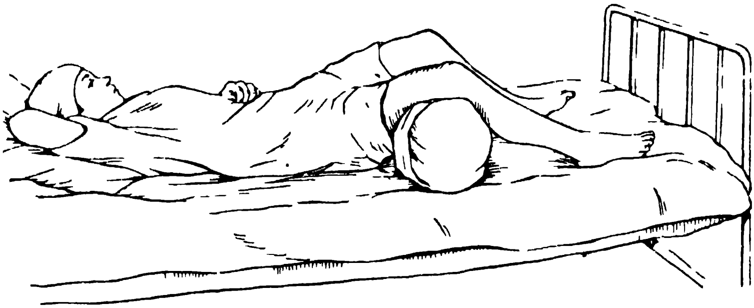


Fig. 309. Position during fracture of the pelvis

injuries caused by falls from considerable heights, railway accidents, etc. They are usually accompanied by other grave traumas to the skeleton and not infrequently by injuries and ruptures of the internal organs (urinary bladder, urethra, intestines, etc.). However, there may be no typical picture of fracture because the deep location of the pelvic bones may often make it impossible to detect any sharp changes in their shape or any abnormal mobility. The symptoms of pelvic fracture include inability to use the lower extremities, i.e., raise the extended legs in a recumbent position, sharp pain on lateral or anteroposterior compression of the pelvis, and in some cases asymmetrical position of the iliac crests. Injury to the pelvic bones is sometimes indicated by affections of the urinary organs (blood in the urine, difficulties of urination, etc.). In such cases the patient must be lifted, carried or transported very carefully to avoid injuring the internal organs by fragments of the bone. Such patients must be lifted and carried as carefully as patients with injuries to the spine. A motionless supine position of the patient with legs flexed in the knees and a bolster placed in the popliteal space—so-called frog's position (Fig. 309)—is a *sine qua non* of treatment. In addition, a splint bandage in the form of a trough for both extremities and the pelvis is used, and in cases of displacement of the bone fragments traction is applied.

If injury to the urinary bladder, urinary tract (blood in the urine, urinary disturbances), or the rectum is suspected, an urgent operation, as was already mentioned above, is performed.

INJURIES AND DISEASES OF THE LIMBS

In *injuries to the soft tissues of the limbs*, especially in cases of splinter wounds, injuries to the nerves manifested in paralyses and disturbances of sensitivity are frequently observed. These injuries require splinting and subsequently surgical and physiotherapeutic treatment.

Injuries to tendons render individual muscles unable to move. The surgical treatment consists in suturing the tendons. Sometimes the tendons are sutured during the primary treatment of the wound, but most frequently after the wound has healed. Grave affections are produced by injuries to the blood vessels, which may be manifested not only in bleeding but also in circulatory disorders in the limb (ischemia: coldness, pains, insensitivity) to the point of gangrene.

In cases devoid of the aforesaid affections the wounds in the soft tissues of the limbs heal rapidly provided, of course, they are not aggravated by anaerobic or purulent infection.

DISLOCATIONS AND FRACTURES OF THE LIMBS

Dislocations of the Shoulder (luxatio humeri). Dislocations most frequently occur in the shoulder joint due to anatomical peculiarities of this joint.

The most vivid sign of dislocation of the shoulder is the forced position of the limb (Fig. 199); during dislocation of the shoulder the patient holds the arm flexed in the elbow and abducted from the body. Compared with the intact side the external appearance of the joint is sharply altered; in the region of the joint the shoulder is not round but angular, below the protruding acromion there is a hollow, and the head of the humerus bulges the soft tissue in the subclavicular region. Edema, observed during the first days, hemorrhage and sharp pain during movement in the region of the joint may disappear, while in old dislocations only a restriction of movement remains.

First aid in dislocations of the shoulder consists in putting the arm in a sling and delivering the patient to a hospital. The only treatment of a traumatic dislocation is reduction which is performed by a physician.

After reduction of a dislocation a bandage is applied to the extremity for a period of 7-10 days, massage and movements in the joint beginning on the 6th or 7th day to quicken the resorption of the effused blood and to strengthen the joint capsule.

Fig. 310. Reducing a dislocated shoulder by Janelidze's method

Since a dislocation is best reduced immediately after it has been sustained, it is desirable that the dislocation should be reduced as soon as possible, especially since the reduction brings the patient relief by diminishing the pains.

Reduction on the second day and later is rendered difficult by great muscular tension, especially in patients with well developed muscles, and is therefore performed under anesthesia. Reduction of a dislocation after 15 days is rarely possible without a surgical operation. If the dislocation is reduced in good time, the functions of the joint are in the overwhelming majority of cases fully restored, whereas surgical reduction results in restricted mobility in the joint and limits the patient's ability to work.

The simplest method of reducing a dislocation of the shoulder is the Janelidze method. The patient is given an injection of 1 ml of a 1 per cent solution of morphine, is placed on a table (on his affected side) with the shoulder joint extending beyond the end of the table, the dislocated arm hanging freely. Some 10-15 minutes later, when the muscles of the shoulder girdle have relaxed, it is enough to press on the internal surface of the forearm bent at a right angle in the elbow joint and held by the wrist (Fig. 310) for the head of the humerus to slip into the articular fossa. The pressure must be exerted sufficiently strongly, but not sharply.

Another method used in reducing dislocations of the shoulder is the Kocher method. This method consists of four parts.

First part. The patient lies on a couch or sits in a chair. The assistant holds the patient by standing behind him and placing the hands on the patient below the clavicles.

The physician takes hold of the patient's upper arm and wrist and, flexing the arm in the elbow, presses it against the chest and downward.

Second part. The physician abducts the flexed forearm and at this time the dislocation is usually reduced.

Third part. If no reduction has been effected, the physician, continuing to abduct the arm raises it by the elbow to the level of the shoulder.

Fourth part. The forearm is rapidly abducted to the chest so that the hand comes to rest above the clavicle on the opposite side.

If the reduction fails, these movements are repeated in the same sequence.

The assistant holds the patient throughout the reduction and prevents his attempts to rise.

Fig. 311. Dislocation of the forearm

Dislocations of the Forearm. Dislocations in the elbow joint occur less frequently, the displacement of the forearm to the rear being more usual and characteristic (Fig. 311). Examination reveals an anteroposterior enlargement of the elbow joint, the olecranon sharply protruding to the rear, a hollow visible above it, and a dense projection in the form of a transverse roll over the elbow fold. First aid consists in bandaging and referring the patient to a hospital. This dislocation is reduced by strong, but not sharp pulling of the forearm downward and forward with a simultaneous fixation of the shoulder.

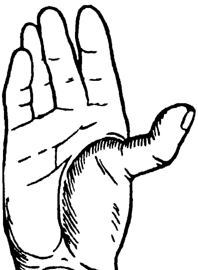


Fig. 312. Dislocation of the thumb

Dislocations of the Thumb (Fig. 312). Dislocations of the thumb are frequently observed. They are very characteristic by their external deformation. In these dislocations it is particularly important to avoid unskilful pulling of the thumb because this may transform a simple dislocation into a complex dislocation which is hard to reduce.

Dislocations of the Thigh (luxatio femoris). Dislocation to the rear is the most usual dislocation of the thigh. In this case the thigh is abducted and turned inward and is held fast in this position. It is almost impossible to abduct and turn the thigh outward, flexion is very limited, and the limb seems shortened. Dislocations of the thigh must not be confused with much more frequent fractures of the neck of the femur. In the latter case the thigh is turned out, rather than in, and mobility is much less limited than it is during dislocations.

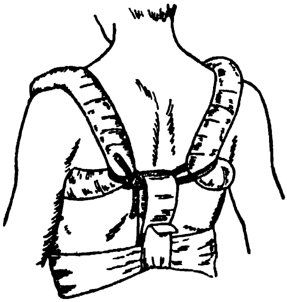


Fig. 313. Annular bandage for fractures of the clavicle

First aid consists in delivering the patient in a recumbent position (this may be done without a splint bandage, but on a good soft litter) to a hospital. Dislocations of the thigh are reduced by the Janelidze method.

Dislocations of the Knee. Dislocations of the knee occur rarely and are sometimes accompanied by rupture of the soft tissue and injury to the vessels. The knee is greatly deformed—a sharp projection of the patella at an angle to the limb in front and a projection of the rear edge of the tibia in the popliteal fossa in the rear. During administration of aid unskillful reduction which leads to rupture of vessels should be avoided. First aid consists in applying a splint bandage in the form of a trough, which extends to the inguinal region, and delivering the patient to a hospital where the dislocation is reduced, usually under anesthesia.

Fractures of the Clavicle. Fractures of the clavicle occur most frequently during falls on the arm or the shoulder joint. These fractures are usually diagnosed without great difficulty because of the change in the configuration of the clavicle which assumes the form of a kink perceptible to the eye. The shoulder is lowered; palpation of the clavicle reveals a protruding fragment, usually the internal. First aid consists in placing the arm in a sling and delivering the patient to a medical institution. After application of an immobilising bandage in the form of rings (Fig. 313) the patient is given ambulatory treatment. The attending personnel must see that the fragments do not break through the skin; if this happens, the fragments have to be united surgically. The fragments usually grow together within 20 days.

Fractures of the Humerus. Fracture of the upper part of the humerus is by external appearance easily confused with dislocation of the shoulder. However, in fractures the head of the humerus is not sunken, as is the case in dislocations. The patient cannot

actively move his arm; not only movement, but also pressure on the humerus along the axis is painful.

Fracture of the humerus in its middle part sharply shortens the extremity, deforms the shoulder (see Fig. 205), imparts abnormal mobility to it along its length and produces crepitus. Fractures in the lower part of the humerus are also characterised by a local enlargement of the humerus, a change in its contour, a shortening and abnormal mobility along the entire humerus.

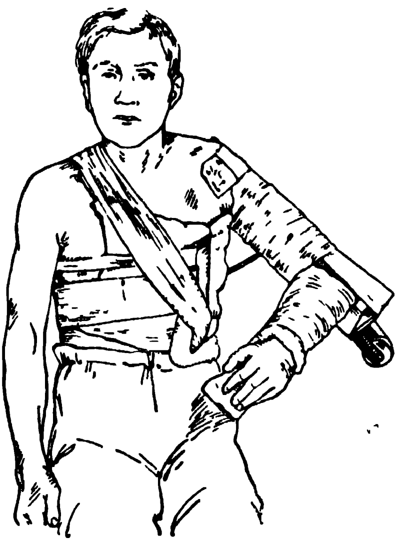


Fig. 314. Abduction splint

First aid in all cases consists in application of a splint bandage in the form of a trough or angle. The bandage must, if possible, cover the shoulder and elbow joints. In the last resort the patient may be delivered to a hospital with the arm bandaged to the body or put in a sling.

Treatment of a fracture of the humeral diaphysis consists in traction in the position of abduction.

The position of physiological rest for the joints of the upper limbs is generally achieved by flexion at a right angle in the elbow joint and abduction in the shoulder joint.

Traction is applied as follows: a strip of plaster 5 cm wide is placed on the medial aspect of the upper arm from the hairy part of the axilla to the medial condyle, then a loop is formed, the loop rounding the elbow and leaving it free; on the lateral aspect of the upper arm the loop reaches the deltoid muscle. A board is placed in the free part of the loop; the traction must be applied along the axis of the upper arm. On the forearm the plaster runs along the palmar surface from the elbow joint to the wrist, whence it passes to the dorsal surface leaving the wrist and the whole hand free and running up to the elbow. If necessary, plaster traction is also applied to the fingers.

Sometimes a spreader is made which can be grasped by the hand.

A gauze bandage is applied to the adhesive plaster strips on the forearm and the upper arm, and a spica bandage to the upper arm is added.

Several apparatus are used for upper limb traction. During traction in cases of fracture of the middle part of the humerus the frag-

ments are properly set only in a position of abduction of the limb from the body. This position is achieved by means of abduction splints which are a combination of splints and abducting triangles (Fig. 314). Such an apparatus can be improvised from wire splints. It is particularly convenient for fractures of the upper and middle thirds of the humerus with considerable displacement, in which the upper fragment is abducted and it is possible to set the frag-

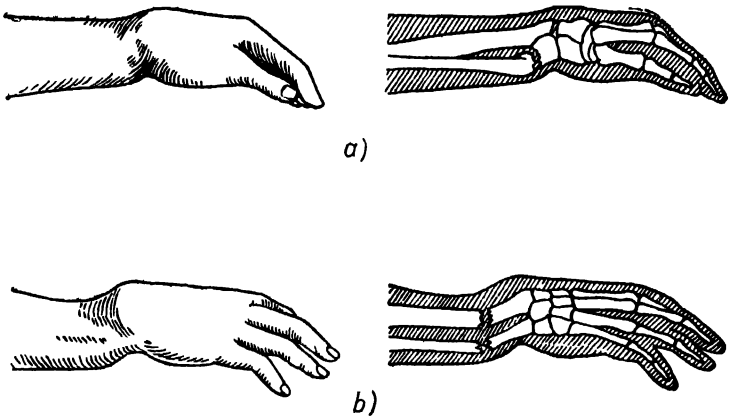


Fig. 315, *a* and *b*. Fracture of the radius and fracture of both forearm bones

ments properly by placing the upper arm in a position of abduction; the separate splints are fastened to each other with wire or plaster bandages.

A dangerous complication in fractures affecting the middle of the humerus is compression of the radial nerve, which results in paralysis of the arm muscles. The only way to prevent this is to set the fragments properly.

Fractures of the Forearm. Fractures of the forearm bones constitute one of the most frequent forms of fractures and are caused mainly by falls on the hands. They occur along the entire length of the forearm, but are most characteristic and usual in its lower part involving either both bones (Fig. 315, *b*) or only the *radius* (Fig. 315, *a*). Externally these fractures are similar.

In both cases the lower end of the forearm is deformed, there is a peculiar bend on its dorsal surface (bayonet-shaped hand), pressure causes pain at the site of fracture, there are no active movements, and passive mobility is limited by pain.

First aid consists in application of a splint bandage with a wire, bast, plywood, cardboard or board splint, after which the patient is sent to a hospital for reposition (setting of the fragments) and immobilisation. Cardboard splints must be made of several lay-

ers of cardboard or must be reinforced with bast or lath otherwise they easily bend in the region of the radiocarpal joint.

In cases of considerable injury to the forearm and hand a splint in the form of a trough is convenient. To make the splint cover the region of the elbow, incisions are made in it and it is bent in the form of a trough.

Treatment of fractures of the forearm is in most cases ambulatory and consists in reposition of the fragments and fixation by means of a plaster bandage.

For reposition of fractured forearm bones traction in special apparatus, for example the Sokolovsky apparatus (Fig. 316), is employed. The traction is effected by a turn of a handle through a system of pulleys after fastening the upper arm.

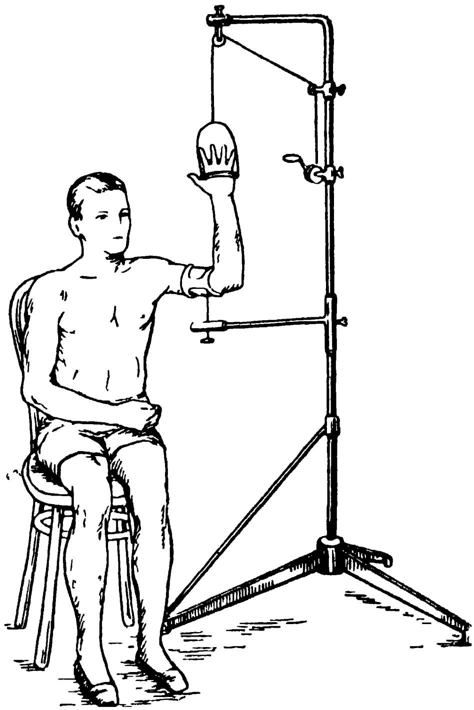


Fig. 316. Reposition of a fracture of the forearm in Sokolovsky's apparatus

The bandage must allow free movements of the fingers. The limb remains in the bandage until union of the bones has been effected Then the limb is given baths, massage and exercise because of a possible limitation of mobility in the fingers and hand.

Fractures of the Fingers. Fractures of the phalanges of the fingers produce a characteristic picture only when the fragments are displaced. A local thickening of the finger, a change in the direction of its axis and its external contours, total immobility, sharp pain on traction and on pressure along the longitudinal axis are observed. Treatment consists in application of a splint bandage along the palmar surface of the finger in a semi-flexed position. It is best to use a metal splint. The splint is moulded beforehand (Fig. 317) and is fastened with a plaster bandage.

In cases of considerable displacement of the fragments it is necessary to employ elastic traction. An adhesive plaster band-

age is applied to the fingers, or a thread is pulled through the nail (Fig. 318). Traction is best applied with the finger flexed. Fig. 319 shows the fingers in a proper functional position. Baths and

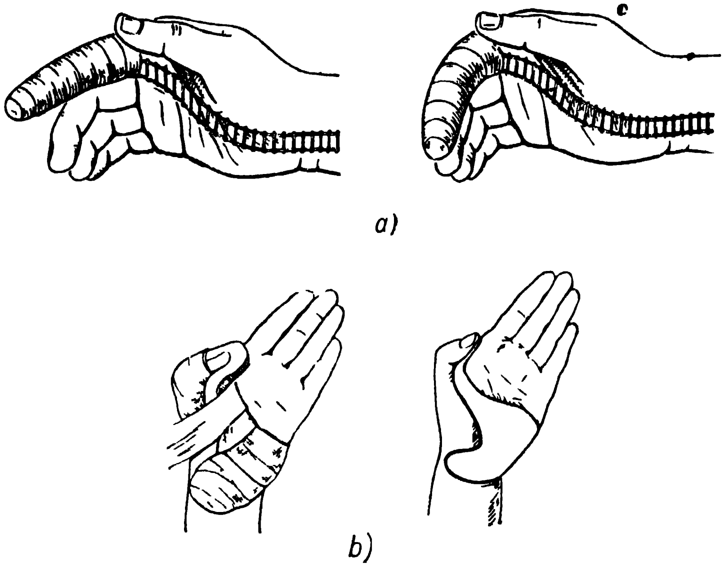


Fig. 317, *a* and *b*. Wire splints for the fingers

massage may be administered as early as 10-14 days after the fracture.

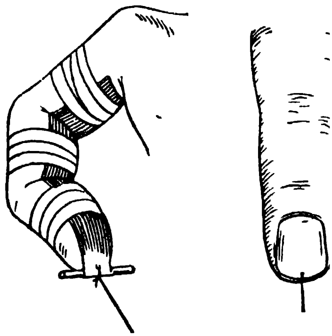


Fig. 318. Finger traction with an adhesive plaster bandage and stitch

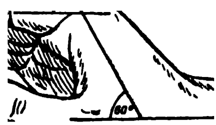


Fig. 319. Physiological position of the hand

Fractures of the Femur. A fracture of the femur is a grave injury and, with the exception of senile cases, occurs only as a result of extreme violence, for example, being run over by a wagon, falling with a weight or from a great height. The picture of the

injury is usually quite characteristic: the patient can neither stand on his leg nor raise it from the ground in a recumbent position; the external appearance of the thigh is changed—it is turned along its longitudinal axis, curved (Fig. 320), shortened, and thickened at the site of the fracture where abnormal mobility and crepitus are observed.

First aid consists in application of a splint bandage covering the whole leg and the pelvic region and running to the axilla. The medial splint extends from the inguinal fold and the external one—from the axilla. Attempts which are not infrequently made to immobilise the area of the fracture with a short splint or by means of a trough-type splint are useless. It is necessary also to immobilise the hip joint, which is achieved only by application of a splint bandage firmly fastened in the pelvic region; pads are placed in the popliteal fossa and under the Achilles tendon. Diterikhs' splint is the most convenient. If there is no ready-made splint, the bandage can be improvised. Such patients must be transported particularly carefully because the fragments of the femur are easily displaced and may produce serious injury to the soft tissues. Subsequently fractures of the femur are treated with traction.

Fig. 320. Fracture in the upper third of the femur. Displacement in the form of riding-breeches

Traction. The muscles of the thigh are stretched the most when the leg is extended. The muscles are relaxed when their points of attachment are closer to each other, i.e., during flexion of the leg in the hip and knee joints. This position of the joints corresponds to the state of so-called physiological rest, i.e., the greatest relaxation of all muscles surrounding the joint, during which the traction of the muscles displacing the fragments ceases.

To impart the position of physiological rest to the limb, i. e., flexion at a 140° angle in the hip and knee joints, and at a right angle in the ankle joint, a so-called double inclined plane is used (Fig. 321).

In such cases a plaster bandage is applied to the lateral surfaces of the shank from the line of the knee joint to the ankles where a free loop begins and rounds the sole; a board with a hole in it is fastened to the loop along the middle axis of the shank. The foot is flexed (at a right angle to the shank) and is immobilised with a strip of gauze glued to the sole, the other end of this strip being passed through a pulley. A strip of plaster (8 cm wide for adults) is applied to the thigh along its medial surface from the inguinal fold to the median condyle; then the strip forms a loop over the knee joint (flexed), is bent over the lateral surface and is

carried to the buttock. The free loop must be big enough to receive a board which is somewhat longer than the diameter of the limb and is of the same width as the strip of plaster.

A 6-10-kg weight, and sometimes heavier, is used for the thigh, 4-6 kg—for the shank.

Since continuous traction, especially by heavy weights, moves the patient towards the foot of the bed, the patient comes to a position in which he rests with his feet against the back of the bed and traction ceases. To prevent the shifting of the patient towards the foot of the bed, he is placed on an inclined plane, the foot of the bed is raised (Fig. 321), and the cords from which the weights are suspended are passed through a system of pulleys (Fig. 322). The patient's body will serve as countertraction.

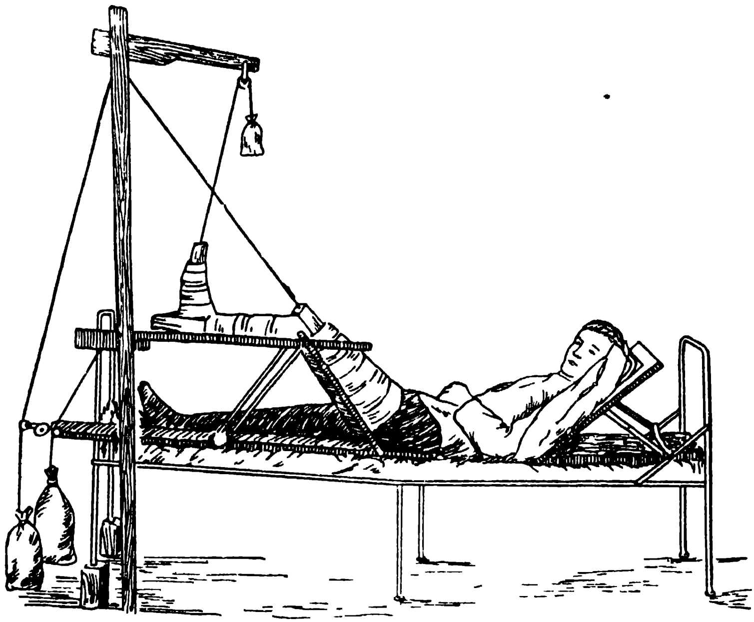


Fig. 321. Thigh and shank traction

A simple device for applying traction to the lower extremity is the so-called Balkan frame. It consists of two uprights, one of which has a longitudinal slit (pulley holders may be installed in the slit at any height) and two horizontal posts of the same length as the bed. The frame is dismountable and is assembled only on location; one upright with the slits for the pulley is fastened to the foot of the bed and the other to the head of the bed, while the lower longitudinal rod is fastened to the uprights of the frame after being passed under the bed. The installation of the

frame is clearly seen in Fig. 324. The uprights can be made by any carpenter and only pulleys are required, but, in the last resort, these can be improvised

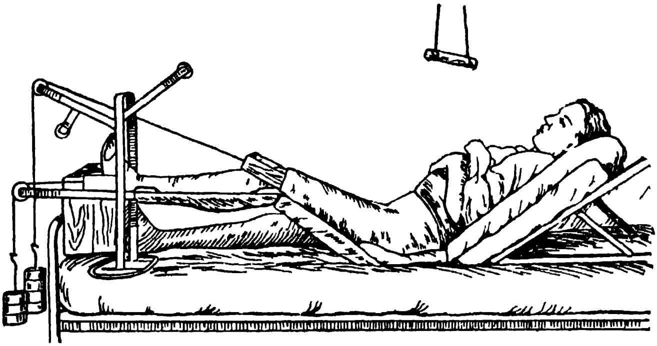


Fig. 322. Traction and system of pulleys

The leg flexed in the hip and knee joints is suspended from the pulleys fastened to this upright Traction applied in this manner enables the patient to exercise in flexing the knee joint and allows him some activity A properly applied bandage with thigh

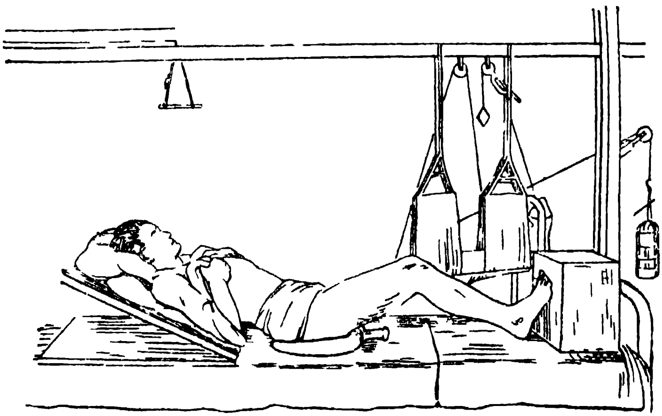


Fig. 323. Placing a bedpan under the patient to whom traction is being applied

traction considerably facilitates the care of the patient, since the latter, by resting his intact leg against the box placed under the bed, can raise his pelvis himself when it is necessary to put a bedpan under him (Fig. 323). However, it is best to use Bohler's splint (Fig. 324). The splint is covered with strips of cloth, and the thigh and shank are placed on them.

Skeletal traction is applied to the shank through a pin passed by means of a special drill through the tuberosity of the tibia. A metal arch is fastened to the spoke, the traction with a weight being applied to this arch by means of a cord passed through the pulley of the splint (Fig. 325).

Fractures of the Bones of the Shank. The most frequent fractures of the lower extremities occur in the bones of the shank. These fractures may result from falling on ice, skating, etc. They take place mostly in the middle and lower parts of the shank. The patient is unable to step on the leg, the shank is swollen and deformed; pathological mobility is usually strongly pronounced; a projection of one of the fragments is usually palpated on the anterior aspect of the tibia.

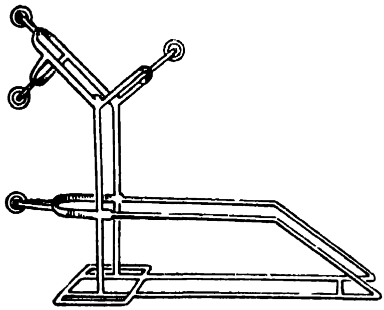


Fig. 324. Bohler's splint

First aid consists in application of a wire or white metal splint bandage or a bandage cut out of cardboard in the form of a trough.

Treatment. In fractures of the middle of the shank with considerable displacement of the fragments reposition is effected and prolonged traction is applied; this is followed by application

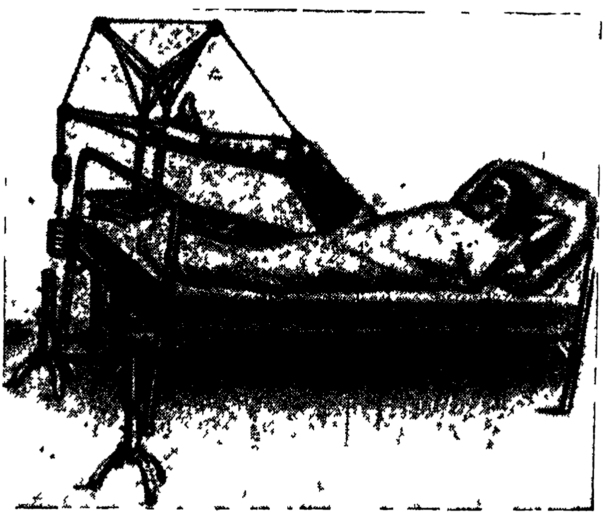


Fig. 325. Skeletal thigh traction

of an unlined bandage with a posterior plaster-impregnated strip and circular plaster bandages. A metal stirrup is added to such a bandage and the patient is allowed to walk. If the fracture involves no displacement of the fragments, the plaster bandage is applied immediately after the injury and within a few days the patient is discharged wearing the bandage with the stirrup (Fig. 326).

During application of the plaster bandage the shank is placed in a position with the knee joint extended and the ankle joint

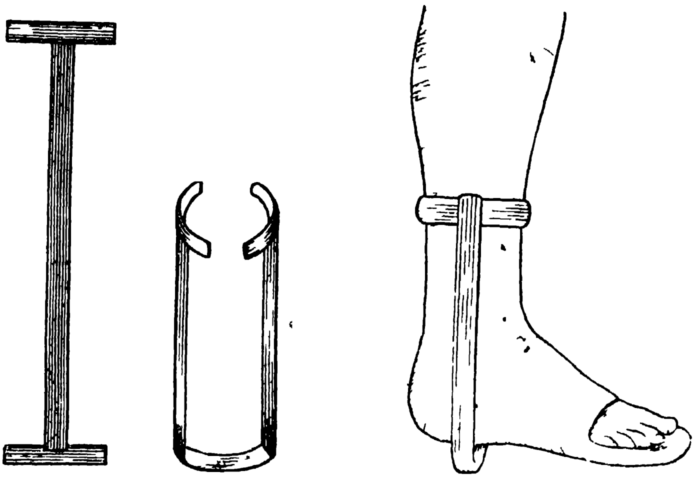


Fig. 326. Metal brace

flexed at a right angle. The tips of the toes point upward and the traction is applied to the toes and the heel. The bandage may be applied circularly or as a plaster-impregnated strip reinforced by circular turns and running along the posterior and plantar surfaces of the foot from the popliteal space to the tips of the toes. It is particularly important to mould the plaster-impregnated strip in the regions of bony points.

In the most frequent cases of malleolar fractures a plaster bandage is applied immediately. If the bone fragments are displaced, reposition is effected first (under local anesthesia). In cases of a bandage with a stirrup, which offers good support, the patient may be allowed to walk on crutches. Fractures of the shank bones heal within two-three months. After union of the fragments the bandage is made removable, and the patient is administered massage and baths. In cases of very extensive displacements which are not amenable to reposition traction by means of a pin passed through the heel bone is applied.

Injuries to Large Joints. Injuries to the large joints constitute a very grave affection and, if aggravated by infection, severely incapacitate the patient and sometimes endanger his life.

Tangent, blind and tunnel wounds, as well as injuries only to the capsule, injuries, with limited affection of the bone and intra-articular gunshot fractures are distinguished.

Injuries affecting only the capsule or limited injuries to the bone usually take a milder course, although they too not infrequently limit mobility, produce contractures and may become aggravated by severe infections of the joints.

In comminuted fractures of articular bones with considerable injury to the epiphysis and cartilaginous surfaces of the capsule and synovial membrane a severe purulent process usually develops.

The *symptoms* of injury to the joint are pain during movement, swelling in the region of the joint and intra-articular hemorrhage. More exact data on the nature of the injury of articular bones are yielded by X-ray examination.

First aid in injuries to the joints consists primarily in earliest possible immobilisation of the extremity with a splint bandage and rapid delivery of the patient to a surgical institution. In cases of slight injury to the joint conservative treatment may be administered after aspirating the blood from the joint, primary treatment of the wound, administration of antibiotics and immobilisation of the limb involving two closest joints by a plaster bandage.

In cases in which the injury is aggravated by infection surgical treatment (opening of the joint or its resection) to create a better outflow for the discharge is resorted to.

In cases of early primary treatment of the wound the capsule of the joint is sometimes sutured, while the subcutaneous tissue is left open.

After the operation plaster bandages are also applied with the limb in a position most advantageous to subsequent function.

Owing to the complexity of structure and depth of their location injuries to such joints as the knee and hip joints particularly frequently produce grave purulent complications (see below) with intermuscular pus accumulations which lead to sepsis.

Management of patients with injuries to the joints is very difficult and must be especially careful. The patient's temperature must be systematically measured and any pyrexia immediately reported to the physician; the integrity of the bandage and proper position of the limb must be maintained and the limb must not be allowed to be compressed by the bandage.

Owing to the intense pain produced by movement, the patient lies motionlessly and may develop bedsores. It is necessary to prevent their appearance by suitable care of the skin at the points of pressure, especially in the sacral region. The medical personnel must be particularly cautious in caring for the patient so as not to affect the immobilisation and not to cause him any suffering.

Acute Serous Inflammation of Joints. The disease sometimes develops after injury to joints, in some cases during an acute inflammatory process near the joints, and at times in different infectious diseases (scarlet fever, pneumonia, typhus and typhoid fever). In a number of cases the cause of this inflammation is not clear.

Serous inflammation most frequently develops in the knee joint involving the synovial membrane of the joint (synovitis). A transparent or slightly turbid serous or serofibrinous fluid accumulates The severity of acute serous or serofibrinous inflammation of the joint varies with its cause. An infectious process may be accompanied by a feverish state; pains and difficulty of movement in the joint are observed in almost all cases. Owing to accumulation of fluid in the joint cavity, the latter becomes greatly distended, the joint becomes enlarged, and its shape and contours change (the recesses of the joint capsule protrude); not infrequently a throbbing in the joint is felt. In such cases the extremity usually assumes the position in which the capacity of the joint cavity is the greatest (most frequently a position of semi-flexion in the joint).

A serous inflammation is the mildest form of inflammation of the joint and usually passes without leaving any traces after resorption of the exudate. In some cases, however, especially in recurring inflammations in one joint, the exudate is not resorbed and the inflammation becomes chronic (hydrarthrosis) or, owing to a shrinking of the joint capsule and intracapsular adhesions, mobility in the joint is permanently limited.

The treatment of serous inflammations of the joint consists in rest, local application of heat, sometimes pressure bandages and punctures of the joint with irrigation of its cavity with penicillin. A long needle and syringe are used for puncturing and irrigating the joint. A pressure bandage is reapplied after the puncture. After abatement of the process and disappearance of the exudate the joint begins to be exercised and massaged.

Pelotherapy and mineral baths help in completely restoring mobility.

Purulent inflammation of the joints (*purulent arthritis*) develops when purulent infection gains entrance into joints during injury, when infection penetrates into joints from adjacent tissues and when infection is brought into joints by the blood stream

in septic cases. Usually the disease begins very violently and acutely, and is one of the gravest purulent processes. If the purulent inflammation is confined only to the cavity of the joint, it is called empyema of the joint. If, in addition to the capsule, the process also involves other parts of the joint and is accompanied by destruction of articular cartilages and a phlegmonous affection of the tissues surrounding the joint, it is referred to as a capsular phlegmon.

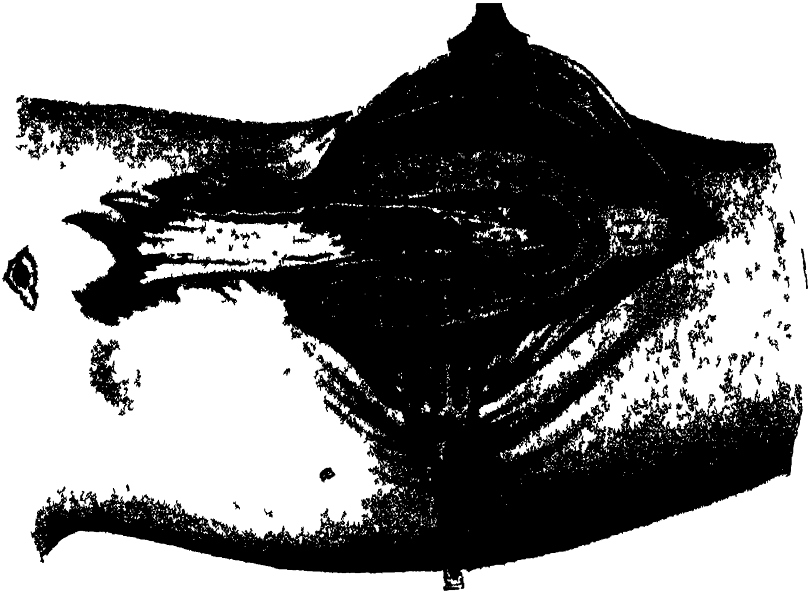
Symptoms. The disease usually begins with sharp pains in the joint, which render movement absolutely impossible. Following this the joint becomes enlarged and even slight contact with it causes pain. The patient's general condition is very grave. The temperature rises sometimes to 40° C, chills appear, the skin covering the affected joint is hot and sometimes inflamed, and red. Destruction of the ligamentous apparatus and of articular cartilages, as well as decomposition of the capsule may subsequently lead to a sharp change in the shape of the joint and a pathological dislocation.

Treatment. In cases of acute purulent inflammation of a joint it is best to administer surgical treatment from the very beginning. This treatment consists in repeated punctures, administration of a penicillin solution into the cavity of the joint or in a broad surgical incision of the joint. The joint must be immobilised, for which purpose splint bandages, sometimes traction, but most frequently immobilising plaster bandages are used. In cases in which the process continues even after the operation and the patient's condition grows worse the affected limb is amputated to save the patient's life.

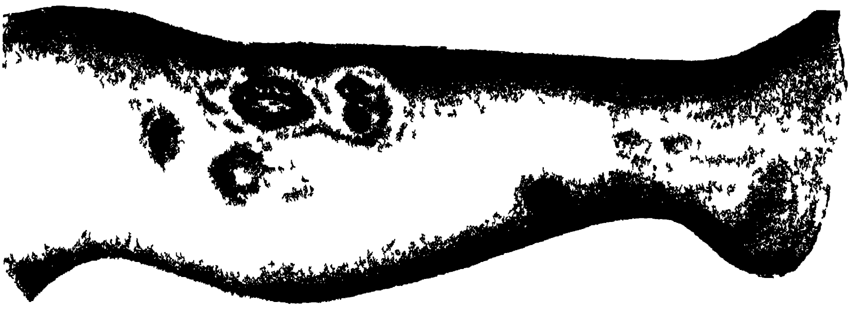
Care of patients suffering from purulent inflammation of a joint is extraordinarily complicated by intense pains produced by the patient's slightest movements; not infrequently the patient not only permits nobody to touch the affected limb, but even complains of pain on contact with the bed.

Owing to the complications which threaten the patient (pus pockets, intermuscular phlegmons, emaciation and sepsis) it is necessary very carefully to watch the patient and the changes in his general condition (pulse, temperature, appetite). The patient's bandage and the position of his limb must also be very closely watched. Despite the extreme sensitivity to touch, the skin is carefully attended to, especially in the region of the sacrum, to prevent bedsores.

Acute Osteomyelitis. Inflammatory processes in bones most frequently begin with inflammation of the bone narrow (osteomyelitis). In most cases the causative agent is the Staphylococcus which gains entrance into the medullary cavity with the blood stream from another purulent focus, in sepsis (hematogenic osteomyelitis), after some disease, for example angina, or through open



Sequestrum during osteomyelitis in the sequestral capsule



Chronic osteomyelitis of the shank (fistulas)

TABLE XVI

Tuberculosis of the knee joint

injuries involving disruption of the periosteum and bone. Osteomyelitis is not infrequently observed in childhood. After penetration into the medullary canal the infection causes an acute inflammatory process, which disturbs the nutrition of a part of the bone marrow, produces partial necrosis and then dissolution of the tissue. The process may be limited or it may spread along the bone, involving new parts of it.

From the medullary cavity the pus may spread along the medullary canals to the adjacent joint or under the periosteum and may detach it. In cases of dissolution and breaches of the periosteum the pus spreads into the intermuscular spaces where it produces a phlegmonous process; the phlegmon opens spontaneously or is opened surgically.

Since the bone is bathed in pus, both inside and outside, its vessels become thrombosed and partial necrosis results.

The detached dead piece of bone forms a sort of foreign body (sequestrum) (Table XV). Since new bone is simultaneously formed from the periosteum, the sequestrum is often surrounded by newly-formed bone (sequestral capsule); in cases of mortification of a large part of bone even a slight injury at the sight of the disease may produce a pathological fracture.

Acute osteomyelitis usually begins suddenly with staggering chills, a sharp rise in temperature and grave general condition of the patient. At the same time intense stinging pains appear in the region of the affected bone and become particularly excruciating at night. The pains are so intense that even adults frequently scream with pain. Examination at the outset of the disease may reveal only local pyrexia, slight edema and extreme painfulness. Subsequently, when the pus penetrates into the intermuscular spaces the disease assumes the character of a deep phlegmon.

The disease may produce complications in the form of purulent inflammations of the adjacent joints and sepsis.

The *treatment* of acute purulent osteomyelitis consists in intramuscular and focal administration of penicillin, and surgical intervention—incision of the focus for more rapid removal of the pus. Treatment with penicillin is administered both before and after the operation.

The *care* of osteomyelitis patients is the same as that of patients suffering from other grave purulent infections. It is necessary carefully to watch the changes in temperature (retention of pus and intermuscular phlegmons are possible), cautiously to apply dressings with a large amount of absorbent material in cases of abundant discharge of pus, and splint bandages to immobilise the limb and prevent possible pathological fracture; the skin at the points of pressure must be taken care of without fail.

Chronic Osteomyelitis. The acute process becomes chronic. The temperature drops. Infected cavities containing sequestra form in the bone. The cavities communicate with the skin through fistulas which discharge a considerable amount of pus (Table XV).

The *pathogenesis* of osteomyelitis resulting from gunshot wounds differs from that of hematogenic origin, the process spreads over considerable portions of the bone, involving affected soft tissues and sequestering bony fragments and ends of bones in the region of the fracture.

Symptoms. Fistulas extending to the bone with a purulent and often ichorous discharge. Introduction of a probe into the fistula reveals a roughness of the bone. Roentgen pictures usually show a cavity with sequestra in it and induration of the bone around the cavity. Fistulas may close up, but aggravations often occur, the picture of the disease simulating acute osteomyelitis; the fistulas reopen (relapsing osteomyelitis) which is particularly characteristic of osteomyelitis following gunshot wounds, in which cases relapses may occur many years after the injury.

Protracted osteomyelitis may give rise to traumatic exhaustion and affection of the internal organs, especially the kidneys (amyloidosis).

Treatment of chronic osteomyelitis is physiotherapeutic; if this proves ineffective and sequestra are present, it is surgical; in cases of aggravation penicillin therapy is employed.

Care of patients consists in application of aseptic bandages and prevention of irritation of the skin surrounding the fistulas (painting with a 5 per cent potassium permanganate solution and application of a zinc ointment).

Continuous irrigation with antibiotics is frequently employed after operations.

TUBERCULOSIS OF BONES AND JOINTS

Tuberculosis of bones is most frequently localised in the joints of the limbs (hip, knee, elbow and shoulder joints).

Each joint has its own characteristic features as regards pathological anatomy, the clinical picture and the treatment.

Tuberculosis of the Shoulder Joint. This is not a frequent disease. Destruction of the bones without decomposition, abscesses and fistulas is characteristic of its dry form. This affection is most frequently observed in adults.

The *symptoms* include pains, limited mobility and atrophy of the muscles in the region of the joint. Roentgenograms reveal atrophy of the bony tissue. The *treatment* is mainly conservative—phototherapy and physiotherapy, and local—a splint bandage.

Tuberculosis of the Elbow Joint. Of all the joints of the upper extremity the elbow joint is most frequently affected mainly in children. The *symptoms* are the same as in tuberculosis of the shoulder joint, namely, pains, limited mobility, swelling (spindle-shaped) of the entire region of the elbow joint, and general feverishness.

In cases of children splint bandages are applied and general treatment for tuberculosis is administered. For adults surgical treatment is preferred.

Tuberculous Gonitis, i. e., tuberculosis of the knee joint is a very frequent disease in which the synovial membrane is affected and considerable exudate (Table XVI) or fibrinous deposits are formed. The disease begins with pains in the joint, weakness in the leg and a spindle-shaped swelling. The joint becomes cramped and during subsequent development of the process fistulas appear. The ligamentous apparatus and the epiphyses of the articular ends are destroyed, owing to which subluxations occur.

Treatment consists in traction and application of plaster bandages. Limited foci in the bone, considerable deformations and late cases indicate surgical treatment.

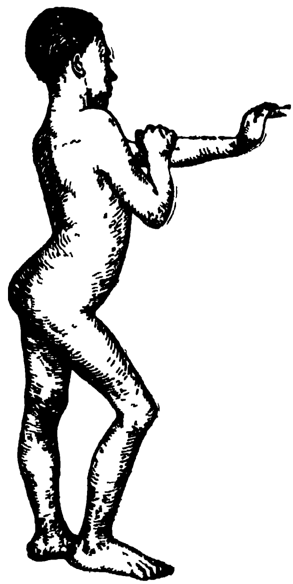


Fig. 327. Tuberculous coxitis

Tuberculosis of the Hip Joint (tuberculous coxitis). Tuberculous affection of the hip joint is second in incidence of tuberculosis of bones. Most frequently one of the bones forming the joint, i.e., the head of the femur or the pelvic bone, is affected and is then followed by destruction of the cartilage and the joint capsule. Destruction of the cartilage and the bone leads to deformation of the joint, appearance of caseous decomposition, accumulation of pus and its break through to the exterior with formation of fistulas. In the beginning of the disease the symptoms may be very negligible—fatigue during walking and pain during movement, especially fast and sudden movements (jumps), appearance of nocturnal pains, diminished mobility, development of articular deformations and, during later periods of the disease, contractures.

Three stages in the development of the process are distinguished: first stage—pain symptoms, enlargement of the joint, flexion, abduction and external rotation of the leg (the patient is still ambulant) (Fig. 327); second stage—further development of

the process, including destruction of the bones forming the joint (destruction of the joint), flexion and abduction of the leg (the patient is confined to bed); third stage—grave destruction, including the ligaments, atrophy of the muscles, pathological dislocations, abscesses and shortening of the limb.

The *treatment* is general (see above) and local—recumbent position, traction and then a plaster bandage which is frequently changed. The disease often results in limited mobility or ankylosis.

The most frequent surgical intervention is extra-articular arthrodesis (creation of immobility in the joint).

The patients require particular *care*, especially if they have intense pains and if traction or a plaster bandage is applied. Con-

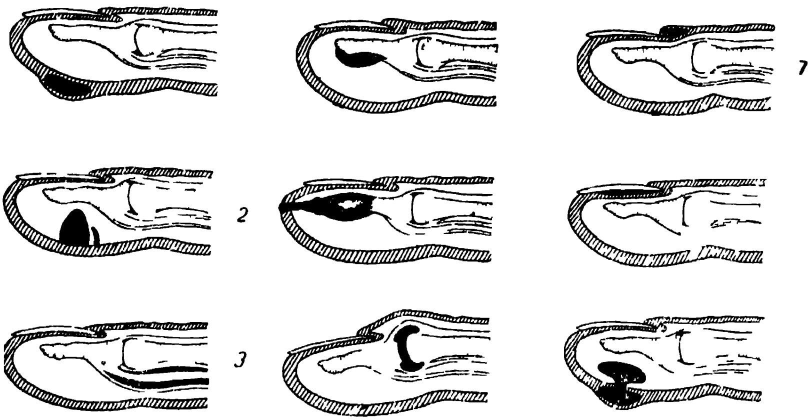


Fig. 328. Diagram of different forms of finger pulp infection

siderable caution must be exercised in placing a bedpan under the patient, changing the linens, etc. Each, even the slightest, movement in the region of the joint may cause pain and may aggravate the process. Moreover, the skin in the sacral region must be sponged particularly carefully to prevent development of bedsores. It is also important that the plaster bandage should not be too tight, and that no abscesses are formed anywhere; in cases of fistulas the rules of asepsis must be carefully observed during dressings.

DISEASES OF THE SOFT TISSUES OF THE LIMBS

Traumas of the upper limbs, injuries and abrasions of the lower limbs are frequent occurrences. Infection easily gains entrance into the wounds and causes purulent processes. It is therefore small wonder that abscesses and phlegmons are so frequently

Purulent tendovaginitis of the middle finger and abscess on the palm

TABLE XVIII

Varicose ulcers of the shank. Varicose veins

observed on the limbs. Such diseases as lymphadenitis (in the axillary and inguinal lymph nodes), lymphangitis and thrombophlebitis most frequently occur and run a characteristic course precisely on the limbs.

Of all the purulent processes on the limbs we shall touch only upon those on the fingers and hands as the most frequently occurring and practically important.

Pulp Infection of the Fingers. The purulent inflammatory process on the finger is called paronychia. There are different forms of pulp infection (Fig. 328):

superficial form, affecting only the skin (*1*), subcutaneous form, involving the subcutaneous tissue (*2*), tendovaginitis, affecting the tissues of the tendons (*3*), bony form involving the bone (*4* and *5*), articular form, attacking the joint (*6*), and paronychia, affecting the nail bed (*7* and *8*). Owing to the peculiar structure of the subcutaneous tissue of the fingers the inflammatory process in them simulates a phlegmon, affects deeper tissues and produces exfoliation of the superficial layers of the skin (*9*).

Mild injuries to the fingers, fissures in the skin, hangnail and bruises serve as the infection gate. Injuries to the fingers constitute about 13 per cent of all the industrial injuries.

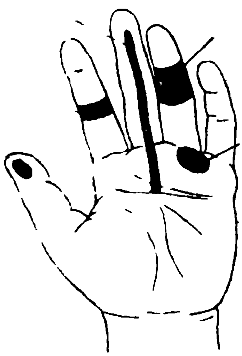


Fig. 329. Zones of pain sensitivity in different forms of finger pulp infection

Symptoms. The disease begins with reddening, swelling and sharp pulsating pains (Fig. 329) on the palmar surface of a phalanx where a small superficial abscess is formed. In subcutaneous pulp infection these phenomena develop very rapidly over a period of several days, the temperature rises and the patient does not sleep nights because of pain. A subcutaneous abscess lasts 7-10 days. The pains subside only after the pus breaks through the skin or after a surgical incision. If the process spreads to the deeper tissues, it affects the bone. Incision in such cases may reveal a denuded phalangeal bone on the floor of the wound (bony form); subsequently this bone is sequestered as necrotic. The process may also involve the tendons (tendovaginitis) and joints (articular form of pulp infection).

The *treatment* consists at first in hot compresses, hot local baths and, if the inflammatory phenomena do not subside in the course of 1-2 days, early incision is indicated after the first sleepless night caused by pain. After surgery the limb is immobilised (application of a bandage or splint) from the very outset of the disease.

Infection of the finger may lead to limited mobility of one finger, as well as of the entire hand; the process may also extend to the hand and forearm and produce sepsis.

Purulent Tendovaginitis. Purulent tendovaginitis most characteristically affects the hand. In cases of paronychia or infected injury to the first or fifth fingers the inflammatory process involves not only the tendon sheath of the affected finger, but also the common tendon sheath of the finger flexors and hand. In pulp infection of the second, third and fourth fingers (Table XVII) the process involves the tendon sheath of the corresponding finger. The symptoms of tendovaginitis include extension of the swelling and redness over the whole finger and farther to the palm and forearm, as well as a sharp limitation of mobility of the fingers. In this disease the patient runs up a fever and is in a generally grave condition. In tendovaginitis not only the palm, but also the back of the hand develops edema. This is a very serious disease which not infrequently leads to invalidity, because of subsequent limited mobility and sometimes complete immobility of the fingers.

The *treatment* consists in administration of penicillin into the capsule of the tendon sheath and an early operation followed by physiotherapy (baths) and early exercise. Only with such treatment is there any hope of recovering the mobility of the fingers.

Prophylaxis of this disease consists in particularly careful attention to the injuries sustained by the fingers and proper treatment of pulp infection.

Hidradenitis. Of the other inflammatory diseases of the limbs mention must be made of inflammation of the axillary sweat glands. The axillary region abounds in sweat glands which, when infected, produce a local inflammatory process. The peculiarity of this disease consists in the fact that the infection very easily spreads from the inflammatory focus to the adjacent glands where new foci appear and the disease runs the same course there as in the first focus. The number of purulent foci determines the duration of the disease.

The *treatment* is at first conservative, i. e., penicillin intramuscularly and under the infiltrate, heat and sun lamp, and subsequently surgical—incision of the foci of malacia.

Prophylaxis consists in observing the rules of personal hygiene, preventing perspiration, and avoiding hot compresses in the axillas.

Varicose Veins. Varicose veins, i e., dilated veins in the form of knots usually interconnected by dilated venous trunks, are most frequently encountered on the lower limbs in the region of ramified subcutaneous veins (varicose veins of the shank and thigh). Varicose veins are caused by diminished tone due to dis-

turbances in innervation and weakness of the vascular wall with subsequent trophic disorders.

Varicose dilation of veins is fostered by mechanical difficulties of the outflow of blood, the appearance of varicosities on the shank being favoured by work connected with long standing, long marches and hard physical work. In all these cases the blood is congested in the ~~veins and~~ its outflow from them is rendered difficult; as a result the veins become distended and dilated, and their walls undergo pathological changes. The basic cause of their dilation is weakness of the venous walls, sclerotic changes in them and underdevelopment of the venous valves.

Symptoms. Patients with varicose veins of the lower limbs complain of a feeling of heaviness in the legs, rapid tiring, cramps in the calves, and subsequently ulcers and eczemas on the shanks and bleeding from the ruptured varicosities. Examination reveals a perfectly clear picture: tortuous and in some places knotty, enlarged cords perceptible through the thinned skin on the shank and sometimes on the thigh (Table XVIII). Sometimes there are clusters of tortuously enlarged veins. These veins are often dense and thrombi with formation of calculi are palpated in them (venous calculi).

The therapeutic measures are aimed at alleviating the patient's condition and improving the blood circulation in order to diminish the tension and sometimes to obliterate the varicosities.

Prophylaxis consists in appropriate vocational selection for work connected with long standing and walking, physical culture and measures aimed at increasing the vascular tone (rubdowns, showers). To prevent complications (ulcers, hemorrhages), wearing elastic bandages or stockings and timely surgical treatment are recommended.

Treatment. In treating varicose veins of the shank it is very important in the first place to eliminate their causes by transferring the patient to work which is not connected with long standing. In milder cases constant bandaging with elastic (knitted) bandages ("Ideal Bandage") is recommended. The bandage is applied in the morning before the patient gets out of bed. Before bandaging the limb is raised for 3-5 minutes. The leg is bandaged evenly with light pressure from the foot to the middle of the thigh; the bandage is removed for the night.

In graver cases, i. e., persistent ulcers, eczemas and recurrent hemorrhages, surgical treatment is resorted to. The operation consists in administering into the varicosities substances which produce thrombosis, obliterate and shrink the vein (sclerosing), for example, up to 5 ml of a 30 per cent sodium salicylate solution. Multiple ligation of the varicosities or their excision produce better results.

The sclerosing substances are administered by a surgeon very carefully because penetration of the solution into subcutaneous tissue produces necrosis of the skin.

To prevent complications in the form of embolisms, especially embolisms of the pulmonary artery, which are possible after excision of the veins, the patients must stay in bed for a period of up to two weeks and must be administered anticoagulants (pelentan, dicoumarin).

Varicose Ulcers. Varicose ulcers develop in varicose veins of the thigh and shank. They are caused by trophic changes in the tissues as a result of circulatory disturbances. Varicose ulcers usually develop as follows: the skin in the lower part of the shank becomes cyanotic and vulnerable because of the congestion of blood (due to disturbed circulation in the varicose veins). Light abrasions of the skin, scratches and furuncles lead to formation of ulcers which do not heal because of poor nutrition of the tissues. If an ulcer has even somewhat healed after protracted treatment, it reopens for a much longer time after a slight new injury or increased hemostasis (long walking and standing). If the patient is not given proper treatment, the ulcer easily grows in extent and deepens, sometimes affecting the entire shank, which is favoured by edema, infiltration of the adjacent tissues and infection. Hemorrhages from the ruptured varicose veins are quite frequent in cases of deepened ulcers. Varicose ulcers are round or oval, have sloping edges, their floor is covered with sluggish cyanotic granulations with a seropurulent film and sometimes a fetid discharge. In protracted cases a dark-brown pigmentation appears around the ulcer. Protracted and persistent ulcers may be aggravated by erysipelas and lymphangitis.

Prophylaxis in cases of varicose veins consists in avoiding scratches and abrasions, wearing an elastic bandage or stocking, and surgical treatment of the varicose veins.

It is difficult to cure varicose ulcers completely. To quicken the healing, it is necessary to improve the blood supply to the shank, for which purpose the patient assumes a recumbent position with his leg raised for long periods of time, the leg is bandaged with an elastic bandage and surgical treatment is administered.

Of local agents moist bandages with a 2 per cent boric acid solution or potassium permanganate solution are applied first. The eczematous surfaces surrounding the ulcer are powdered with zinc oxide or are coated with a zinc paste. After cessation of the fetid discharge and improvement of the type of granulations stimulating ointments are used (Argenti nitrici 0.25; Balsami Schostakowsky 3.0; Lanolini 3.0; Vaselini 3.0; M. f. ung. DS).

A method of treating varicose ulcers under a plaster (zinc-glue) bandage (applied to the ulcers or even the whole leg) has gained currency. The bandage is applied as follows after a bath and thorough cleansing of the whole leg, powdering the ulcers with penicillin and coating the skin around the ulcers with a zinc paste, the entire surface of the foot and shank is coated with a heated zinc glue (Zinci oxydati, Gelatinae $\overline{aa}$ 20.0; Aquae destillate 80.0) and is then bandaged with 3-4 layers of gauze, each layer being coated with glue. The bandages are changed once or twice a week, depending on how soon they become soaked.

CONGENITAL AND ACQUIRED DEFORMITIES

The field of congenital and acquired deformities of the skeleton and limbs is so vast and their surgical treatment is so specific that they constitute a special branch of surgery—orthopedics.